KAPL-4873

## Knolls Atomic Power Laboratory

# Environmental Monitoring Report

## Calendar Year 2013

Operated for the U. S. Department of Energy
by Bechtel Marine Propulsion Corporation

PRINTED ON RECYCLED PAPER

KAPL- 4873

# KNOLLS ATOMIC POWER LABORATORY

# ENVIRONMENTAL MONITORING REPORT

## CALENDAR YEAR 2013

**This report contains data and information for the government owned sites comprising the Knolls Atomic Power Laboratory operated for the Department of Energy by Bechtel Marine Propulsion Corporation, Schenectady, New York.**

**Bechtel Marine Propulsion Corporation**
**KNOLLS ATOMIC POWER LABORATORY**
**Schenectady, New York**
**Operated for the United States Department of Energy**
**Contract DE-NR0000031**

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# CONTENTS

## CONTENTS (Continued)

## CONTENTS (Continued)

# CONTENTS (Continued)

# TABLES

# TABLES (Continued)

# TABLES (Continued)

# FIGURES

## LIST OF ACRONYMS

| | |
|---|---|
| AE | Air Emission |
| AFR | Air Facility Registration |
| ASGTF | Advanced Steam Generator Test Facility |
| BCSF | Bulk Chemical Storage Facility |
| BMPC | Bechtel Marine Propulsion Corporation |
| BOD-5 | Biochemical Oxygen Demand, 5-day test |
| BTU | British Thermal Unit |
| CAA | Clean Air Act |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COD | Chemical Oxygen Demand |
| CWA | Clean Water Act |
| CX | Categorical Exclusion |
| D&D | Decontamination and Decommissioning |
| DCG | Derived Concentration Guide |
| DEQ | Department of Environmental Quality |
| DO | Dissolved Oxygen |
| DOE | U. S. Department of Energy |
| DOE-EM | U. S. Department of Energy-Office of Environmental Management |
| DOT | U. S. Department of Transportation |
| EPA | U. S. Environmental Protection Agency |
| EMS | ESH Management System |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| ESH | Environment, Safety, and Health |
| FFCA | Federal Facility Compliance Act |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| HSWA | Hazardous and Solid Waste Amendments |
| KAPL | Knolls Atomic Power Laboratory |
| LDR | Land Disposal Restrictions |
| LEPC | Local Emergency Planning Committee |
| MBAS | Methylene Blue Active Substances |
| MS4 | Municipal Separate Storm Sewer System |
| MTBE | Methyl Tertiary Butyl Ether |
| NAAQS | National Ambient Air Quality Standards |
| NCP | National Contingency Plan |
| NEPA | National Environmental Policy Act |
| NNPP | Naval Nuclear Propulsion Program |
| NOx | Oxides of Nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NESHAPs | National Emission Standard for Hazardous Air Pollutants |
| NR | Naval Reactors |
| NRC | U. S. Nuclear Regulatory Commission |
| NYS | New York State |
| NYSDEC | New York State Department of Environmental Conservation |
| PBSF | Petroleum Bulk Storage Facility |
| PCB | Polychlorinated Biphenyls |
| POTW | Publicly Owned Treatment Works |
| PQL | Practical Quantitation Limit |

## LIST OF ACRONYMS (Continued)

| | |
|---|---|
| QAP | Quality Assurance Program |
| RAE | Radionuclide Air Emission |
| RCRA | Resource Conservation and Recovery Act |
| RQ | Reportable Quantity |
| SA | Sustainable Acquisition |
| SCF | Standard Cubic Feet |
| SCU | Stationary Combustion Unit |
| SEA | Site Evaluation Accomplished |
| SERC | State Emergency Response Commission |
| SIC | Standard Industrial Classification |
| SPDES | State Pollutant Discharge Elimination System |
| SPRU | Separations Process Research Unit |
| SPRU DP | Separations Process Research Unit Disposition Project |
| STP | Site Treatment Plan |
| SWDA | Solid Waste Disposal Act |
| SWMP | Stormwater Management Program |
| SWPPP | Stormwater Pollution Prevention Plan |
| SWMU | Solid Waste Management Unit |
| TKN | Total Kjeldahl Nitrogen |
| TLD | Thermoluminescent Dosimeter |
| TOC | Total Organic Carbon |
| TON | Total Organic Nitrogen |
| TRI | Toxic Release Inventory |
| TSCA | Toxic Substances Control Act |
| TSDF | Treatment, Storage, and Disposal Facility |
| TSS | Total Suspended Solids |
| VIMGA | Vacuum Induction Melting/Gas Atomization |
| VOC | Volatile Organic Compound |
| WET | Whole Effluent Toxicity |

## OTHER COMMON ABBREVIATIONS

| | |
|---|---|
| CFU/100ml | colony-forming units per 100 milliliters |
| F | Fahrenheit |
| GPD | gallons per day |
| μCi | microCurie = $1 \times 10^{-6}$ Curie |
| μCi/ml | microCuries per milliliter |
| μg/l | micrograms per liter |
| mg/l | milligrams per liter |
| MGD | million gallons per day |
| mrem | millirem |
| ml | milliliters |
| pCi | picoCurie = $1 \times 10^{-12}$ Curie |
| pCi/gm | picoCuries per gram |
| pCi/l | picoCuries per liter |
| SU | Standard Units |

# 1.0 EXECUTIVE SUMMARY

The results of the effluent and environmental monitoring programs at the Knolls Atomic Power Laboratory (KAPL), Knolls Site and Kesselring Site, are summarized and assessed in this report. Table 1-1 summarizes the major elements of the environmental monitoring programs at each site. Information regarding the Department of Energy – Environmental Management (DOE-EM) Separations Process Research Unit (SPRU) Disposition Project is also included in this report. Operations at the Knolls Site, which includes SPRU, and Kesselring Site continue to have no adverse effect on human health and the quality of the environment.

The effluent and environmental monitoring programs conducted by KAPL are designed to determine the effectiveness of treatment and control methods, to provide measurement of the concentrations in effluents for comparison with applicable standards, and to assess resultant concentrations in the environment. The monitoring programs include analyses of samples of liquid and gaseous effluents for chemical constituents and radioactivity as well as environmental monitoring of air, water, sediment, and fish. Radiation measurements are also made around the perimeter of the Knolls Laboratory and Kesselring Site and at off-site background locations.

KAPL environmental controls are subject to applicable Federal, State, and local regulations governing use, emission, treatment, storage, and/or disposal of solid, liquid, and gaseous materials. Some nonradiological water and air emissions are generated and treated on-site prior to discharge to the environment.

Nonradiological liquid effluents from the Knolls Site and Kesselring Site are controlled and monitored in accordance with permits issued by the New York State Department of Environmental Conservation (NYSDEC). Radiological liquid effluents are controlled and monitored in accordance with U.S. Department of Energy (DOE) requirements. Liquid effluent monitoring data show that KAPL has maintained a high degree of compliance with the New York State and DOE requirements. At the Knolls Site, sewage discharges are controlled and monitored in accordance with limitations imposed locally by the Town of Niskayuna in accordance with an Outside Users Agreement.

Nonradiological air emissions from the Knolls Site and Kesselring Site are controlled and monitored in accordance with NYSDEC and U.S. Environmental Protection Agency (EPA) air regulations. Radionuclide air emissions are regulated by the EPA under the requirements of NESHAPs (40 CFR 61, Subpart H). For the purposes of the radionuclide NESHAPs regulations both the Knolls Laboratory and SPRU are considered one site (Knolls Site). Nonradiological air emission sources are not required to have stack monitoring. The use and maintenance of air emissions control equipment, fuel usage and tracking, or air source limitations such as fuel oil sulfur concentration limits, are used to demonstrate compliance. All KAPL air emissions were within applicable Federal and State standards.

The DOE and EPA signed a Consent Order on March 1, 2012, as a result of EPA's investigation into the September 29, 2010 unplanned release of airborne radioactivity experienced by the SPRU project during open air demolition of Building H2. While the amount of radioactivity released off-site was small, EPA's investigation into the event determined that DOE was not in compliance with the radionuclide NESHAPs regulations in several aspects. All of the short term corrective actions specified in the Consent Order were completed in May 2012. On June 5, 2012, EPA Region 2 informed DOE of EPA's conclusion that the Knolls Site was back in compliance with the radionuclide NESHAPs regulations. The remainder of the corrective actions specified in the Consent Order were completed on February 28, 2013.

The Knolls Laboratory and the Kesselring Site operated their own landfills for KAPL-generated nonradiological wastes during their early history. The Knolls Laboratory and the Kesselring Site landfill operations were terminated in 1993 and 1994, respectively. Nonhazardous solid wastes are disposed of off-site through local permitted facilities.

Chemicals are not manufactured at KAPL but are used incidental to the Knolls Laboratory and Kesselring Site operations. Those substances characterized as hazardous by Federal and State regulations are controlled through administrative procedures and personnel training. Small amounts of chemical wastes are generated and disposed of off site by waste vendors operating under permits issued by the cognizant Federal and State regulatory agencies. Handling and storage incidental to shipment of wastes are controlled and monitored by trained personnel in compliance with applicable permits and regulations. KAPL strives to minimize the quantity of hazardous and solid waste that it produces. Waste avoidance, beneficial reuse, and recycling are practiced whenever practicable.

Accountability and radiation survey procedures are used at the Knolls Laboratory, including SPRU, and the Kesselring Site for the handling, packaging, and transportation of all radioactive materials. Shipments of radioactive materials are performed in accordance with detailed written procedures to ensure compliance with all applicable regulations of the U.S. Department of Transportation (DOT), the U.S. DOE, and the U.S. Nuclear Regulatory Commission (NRC). All KAPL generated wastes that contain radioactive constituents are regulated under the Atomic Energy Act of 1954 and applicable DOE requirements. The volume of solid radioactive waste that requires disposal is minimized using procedures that limit the amount of materials that become contaminated and by recycling. Radioactive wastes are shipped to government owned or licensed disposal sites. During 2013, approximately 2,653 cubic meters (3,469 cubic yards) of low-level radioactive waste were shipped from the Knolls Laboratory, SPRU, and the Kesselring Site for disposal. The majority of this volume was due to SPRU demolition debris, soil, and water.

The Knolls Site and the Kesselring Site are within the DOE and EPA standards governing the release of radioactivity to the environment. The annual average concentration of KAPL radioactivity in liquid and gaseous effluents at the boundary of each Site corresponded to less than one percent of the permissible DOE radioactivity concentration guides. Radionuclide air emissions were also less than one percent of the EPA air emission standard. Radiation dose to the general public as a result of KAPL operations was too small to be measured and, therefore, must be estimated using conservative calculational techniques that provide an upper bound on the potential dose. The maximum potential annual dose to an individual off-site was less than 0.1 millirem per year. This is less than one percent of the numerical guide established by the NRC for commercial reactor sites to demonstrate that radioactive materials in effluents released to unrestricted areas are as low as reasonably achievable. The maximum potential annual dose is also less than ten percent of the total radiation a person aboard a commercial airplane would receive from cosmic sources during one coast-to-coast flight. The estimated annual collective dose to the entire population within 80 kilometers (50 miles) of either KAPL Site was less than 0.1 person-rem, which corresponds to less than one thousandth of one percent of the dose received by that population from normal background radiation.

In summary, the operations and activities at the Knolls Site and the Kesselring Site continue to have no adverse effect on human health or the quality of the environment.

To improve clarity in this report the following naming conventions are used:

- Knolls Atomic Power Laboratory (KAPL) refers to operations that affect, or the corporate entity that oversees both facilities dedicated to the Naval Nuclear Propulsion Program (NNPP) at Niskayuna and West Milton, New York.
- Knolls Site refers to the NNPP facility and includes the SPRU project in Niskayuna, New York.
- Knolls Laboratory refers to the NNPP facility in Niskayuna, New York only.
- Kesselring Site refers to the NNPP facility in West Milton, New York only.
- SPRU refers to the overall DOE-EM SPRU project in Niskayuna, New York.
- SPRU DP refers to the SPRU Disposition Project which is the portion of the SPRU project involved with the Buildings G2 and H2 Decontamination and Demolition (D&D) in Niskayuna, New York.

# TABLE 1-1 SUMMARY OF KAPL ENVIRONMENTAL MONITORING PROGRAM

| Knolls Laboratory Radiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Outfalls and Streams | | |
| • Outfall 002 | Monthly – Continuous Composite Sample | Gross Alpha, Gross Beta<br>H-3, Sr-90, Cs-137 |
| • Outfall 03A<br>• Outfall 03D<br>• Outfall 03E<br>• Lower Level Parking Lot Seepage | Monthly – Grab Sample | Gross Alpha, Gross Beta<br>Sr-90 |
| | Quarterly Composite Sample | Cs-137 |
| • Outfall 004 (Lower Level Road Ditch) | Monthly – Grab Sample | Gross Alpha, Gross Beta,<br>Sr-90, Cs-137 |
| • Outfall 03B<br>• West Landfill Stream | Monthly Grab Samples taken and combined into a Quarterly Composite for analysis | Gross Alpha, Gross Beta;<br>Sr-90, Cs-137 if Gross Beta >10 pCi/l |
| • Upper West Boundary Stream (Background)<br>• Mohawk River – Incoming river water to Lower Level Pumphouse (Outfall 001) (Background) | Monthly - Grab Sample | Gross Alpha, Gross Beta<br>H-3, Sr-90, Cs-137 |
| • East Boundary Stream (Upper and Lower (Outfall 006))<br>• Middle Stream (Outfall 005) | Monthly Grab Samples taken and combined into a Quarterly Composite for analysis | Gross Alpha, Gross Beta<br>Sr-90, Cs-137 |
| • Mohawk River Bank Seepage | At least annually | If sufficient sample volume:<br>Gross Alpha, Gross Beta<br>Sr-90, Cs-137 |
| Sanitary Effluent | Weekly – 24-hour composite sample | Gross Alpha, Gross Beta |
| | Quarterly Composite of weekly samples | H-3, Co-60, Sr-90, Cs-137, Uranium |
| Municipal Drinking Water Systems<br>• Schenectady<br>• Niskayuna<br>• Latham/Colonie | Monthly Grab Samples taken and combined into a Quarterly Composite for analysis | Gross Alpha, Gross Beta;<br>Sr-90, Cs-137 if Gross Beta >10 pCi/l |
| Knolls Site Service Water | Monthly - Grab Sample | Gross Alpha, Gross Beta,<br>H-3, Sr-90, Cs-137 |
| Mohawk River Water | | |
| • 1000 feet upriver<br>• 3000 feet downriver | Second, Third, and Fourth Quarters | Gross Alpha, Gross Beta;<br>Sr-90, Cs-137 if Gross Beta >10 pCi/l |
| • 2000 feet upriver<br>• 4500 feet downriver | Second, Third, and Fourth Quarters | Gross Alpha, Gross Beta,<br>Sr-90, Cs-137 |
| Mohawk River Sediment | Second, Third, and Fourth Quarters | Gross Beta, Cs-137, Uranium, Plutonium; Sr-90 on seven sediment samples in second quarter sample set only |

## TABLE 1-1 SUMMARY OF KAPL ENVIRONMENTAL MONITORING PROGRAM (Continued)

| Knolls Laboratory Radiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Mohawk River Fish<br>• Upriver above Lock 7<br>• Downriver below Outfall 002 | Annually | Sr-90, Cs-137, Plutonium |
| Groundwater | Annually | Gross Alpha, Gross Beta, H-3, Sr-90, Cs-137 (Well points – H-3 only) |
| Stack Air Effluents | | |
| • Particulate Radioactivity<br>• Radioiodine | Weekly | Gross Alpha, Gross Beta on Filter Papers; Gamma Spectrometry on Charcoal Cartridges |
| • Krypton-85 | Continuous | Noble Gas Monitor System |
| Environmental Air | | |
| • Particulate Radioactivity | Weekly | Gross Alpha, Gross Beta on Filter Papers |
| • Radioiodine | Bi-monthly | Gamma Spectrometry on Charcoal Cartridges |
| Environmental Radiation | Quarterly | Gamma Radiation |

| Knolls Laboratory Nonradiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Outfalls and Streams | | |
| • Outfall 002 | Continuous | Flow, Temperature |
| | Weekly | pH, TSS, Oil & Grease, Total & Net Total Copper (when Copper Ion Generator is in use) |
| | Quarterly (during calendar years ending in “2” or “7”) | Whole Effluent Toxicity (WET) Testing |
| • Outfall 03B | Continuous | Flow, Temperature |
| | Weekly | Total & Net Total Copper (when Copper Ion Generator is in use) |
| | Monthly | pH, Net TSS, Oil & Grease |
| • Outfall 03S | Semi-monthly | Flow, TSS |
| • Outfall 03T | Weekly | Flow |
| | Semi-monthly | TSS and Percent Removal |
| • 03D | Continuous | Flow, Temperature |
| | Weekly | Total & Net Total Copper (when Copper Ion Generator is in use) |
| | Monthly | pH, TSS, Oil & Grease |
| • 03A | Quarterly | Flow, pH, TSS, Oil & Grease |

## TABLE 1-1 SUMMARY OF KAPL ENVIRONMENTAL MONITORING PROGRAM (Continued)

| Knolls Laboratory Nonradiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| • 03E | Quarterly | Flow, pH, TSS, Oil & Grease |
| • Outfall 004<br>• Outfall 005<br>• Outfall 006 | Quarterly | Flow, pH, TSS, Oil & Grease, COD, Chloride, VOCs [Outfalls 004 & 005 only] (EPA 601) |
| • West Landfill Stream<br>• East Boundary Stream, Upstream<br>• East Boundary Stream, Downstream (Outfall 006) | Bi-annually concurrent with landfill well sampling | Flow, Temperature, pH, DO, Specific Conductance, Chloride, VOCs (EPA 601) |
| • Mohawk River Upstream (Outfall 001) | Weekly | Flow, pH, TSS, Total Copper (when Copper Ion Generator is in use) |
| | Quarterly | Chloride |
| • Mohawk River Downstream | Quarterly | Chloride |
| Sanitary Effluent | Daily | Flow, pH |
| | Weekly 24-hour composite | BOD, COD, TSS, Ammonia, Nitrate, Nitrite, TKN, TON, Nitrogen, Phosphate, Oil & Grease |
| Groundwater | | |
| • Landfill Wells | Bi-annually | Field Parameters, VOCs (EPA 601) |
| • Land Area | Annually | Field Parameters, Filtered & Unfiltered Metals, Turbidity, VOCs (EPA 601 and 602) |
| • Hillside and Lower Level | Annually | Field Parameters, VOCs (EPA 601 and 602) |
| • Hillside Remediation Wells | Annually | Acetone, Hexane (EPA 624), Field Parameters, VOCs (EPA 601 and 602) |

# TABLE 1-1 SUMMARY OF KAPL ENVIRONMENTAL MONITORING PROGRAM (Continued)

| Kesselring Site Radiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Liquid Effluent | | |
| • Retention Basins<br>• Outfalls 001, 002 | Monthly Composite<br>Monthly Grab Sample | H-3, Co-60 |
| Glowegee Creek Water | Quarterly | Co-60 |
| Glowegee Creek Sediment | Quarterly | Co-60 |
| Glowegee Creek Fish | Annually | Co-60 |
| Groundwater (Hogback Road Landfill, Developed Area, and Perimeter Area Wells) | Annually | H-3, Co-60, Cs-137 |
| Stack Air Effluents | | |
| • Particulate Radioactivity | Bi-monthly | Co-60 |
| • Radioiodine | Bi-weekly | I-131 |
| • H-3/C-14 | Weekly | H-3/C-14 |
| Environmental Air | | |
| • Particulate Radioactivity | Bi-monthly | Co-60 |
| • Radioiodine | Bi-weekly | I-131 |
| Environmental Radiation | Quarterly | Gamma Radiation |

| Kesselring Site Nonradiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Outfalls | | |
| • Outfall 001<br>• Outfall 002 | Daily, when discharging from Outfalls 001 and 002 | Flow, Temperature, Total Residual Chlorine |
| | Monthly | pH, Oil & Grease, Total Suspended Solids, Nitrite as N, Total Iron, Total Phosphorus, Total Zinc, Total Boron, Total Sulfite, Ammonia as NH3 |
| • Outfall 003 | Daily | Flow |
| | Week Days | Settleable Solids, pH, Dissolved Oxygen, Temperature |
| | Monthly | Nitrite as N, Available Cyanide, Ammonia as NH3, Total Surfactants (MBAS), Dissolved Copper, BOD-5, TSS, Total Phosphorus, Total Zinc, Total Copper, Total Iron, Total Boron, Total Aluminum, Butyl Benzyl Phthalate |
| • Outfall 02B | Monthly | Nitrite as N, Ammonia as N, Total Residual Chlorine |
| Glowegee Creek Water | Daily, when discharging from Outfalls 001 and 002 | Temperature |
| Glowegee Creek Fish | Annually | Species Survey |

## TABLE 1-1 SUMMARY OF KAPL ENVIRONMENTAL MONITORING PROGRAM (Continued)

| Kesselring Site Nonradiological Environmental Monitoring Program | | |
|---|---|---|
| **Media Monitored** | **Analysis Frequency** | **Routine Analysis** |
| Groundwater | | |
| • Hogback Road Landfill | Annually | Field Parameters, Modified Routine List, VOCs (SW-8021B) |
| • Developed Area | Annually | Field Parameters, VOCs (EPA 601 and 602) |
| Drinking Water System | | |
| • Entry Point to the Distribution System | Daily | Free Chlorine Residual |
| | Annually | Nitrates, Nitrites, Disinfection Byproducts (Trihalomethanes, Haloacetic Acids) |
| | Every 3 years | Group 1 and Group 2 Pesticides, Dioxin, and PCBs, Arsenic, Barium, Cadmium, Chromium, Mercury, Selenium, Fluoride, Antimony, Beryllium, Nickel, Sulfate, Thallium, Cyanide |
| | Every 9 years | Asbestos |
| • Distribution System (various locations) | Minimum three per month | Total Coliform, Free Chlorine Residual |
| | Every 3 years | Lead, Copper, |
| • Treatment Locations | Every 3 years | VOCs, Vinyl Chloride, and MTBE (EPA 524.2) |

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# 2.0 INTRODUCTION

KAPL is operated by Bechtel Marine Propulsion Corporation (BMPC), under contract with the DOE. KAPL consists of two separate sites: the Knolls Laboratory and the Kesselring Site both of which are United States Government owned facilities. The principal function at KAPL is research and development in the design and operation of naval nuclear propulsion plants. The Kesselring Site is also used for the training of personnel in the operation of these plants.

The Knolls Site is located in the Town of Niskayuna, New York, approximately two miles (3.2 kilometers) east of the City of Schenectady (Figure 2-1). The Knolls Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Laboratory include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, a small municipal park, and suburban residential areas.

The Separations Process Research Unit (SPRU) was operated at the Knolls Site from 1950 to 1953 as a pilot plant to research chemical processes to extract uranium and plutonium from irradiated uranium. The historical SPRU operations resulted in contamination of the facilities (Buildings G2 and H2, also known as the SPRU Disposition Project or SPRU DP) and land areas where waste handling operations occurred. The SPRU work is being performed by separate contracts under the Department of Energy - Environmental Management (DOE-EM). URS Energy and Construction, Inc. (URS) is under contract for the Buildings G2 and H2 areas. The Accelerated Remediation Company, Inc. (aRc) was previously under contract for the remediation of the land areas, which was completed in 2010. Information on the SPRU project is provided in Section 6.0 of this report. Separate information can also be found at the DOE-EM website *http://www.spru.energy.gov*.

The Kesselring Site is located near West Milton, New York, approximately 17 miles (27.4 kilometers) north of the City of Schenectady, nine miles (14.5 kilometers) southwest of Saratoga Springs and 13 miles (21 kilometers) northeast of Amsterdam (Figure 2-1). The Site consists of 3900 acres on which are located two operating pressurized-water naval nuclear propulsion plants and support facilities, including administrative offices, machine shops, training facilities, equipment service buildings, chemistry laboratories, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and wastewater treatment facilities. Two other nuclear propulsion plants at the Site have been permanently shut down: the S3G plant during 1991 and the D1G plant during 1996. These plants have been defueled and dismantlement work, which began in 1998 after completion of the National Environmental Policy Act (NEPA) process, is continuing. The dismantlement of the S3G plant was completed in 2006. The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

Liquid effluents are monitored at the Knolls Laboratory and the Kesselring Site for the chemical parameters listed in the applicable State Pollutant Discharge Elimination System (SPDES) permits and for radioactivity. At the Knolls Laboratory, the Outside Users Agreement with the Town of Niskayuna specifies the chemical parameters required to be monitored in the sanitary sewage effluent. Analyses are also performed on effluent and receiving stream water samples for select chemical parameters, some of which have State water quality standards. At the Knolls Laboratory and the Kesselring Site, fish, water, and bottom sediment samples from the receiving streams are collected and analyzed for radioactivity. Nonradiological industrial air emission sources do not require continuous monitoring under the terms of current New York State air regulations due to the combustion fuels used and the very low levels of emissions from overall operations at KAPL. Airborne effluents from the main radiological emission points are continuously sampled for radioactivity. Other minor radiological emission points are evaluated for the potential for release and a periodic measurement protocol is used to confirm the low radionuclide emissions. In addition, radiation levels around the perimeter of Knolls Laboratory and the Kesselring Site and at several off-site background locations are monitored with sensitive thermoluminescent dosimeters.

The quantities of radioactivity contained in liquid and gaseous effluents during operations in 2013 at the Knolls Laboratory and the Kesselring Sites were too small to have a measurable effect on normal background radioactivity. Solid radioactive wastes are packaged and shipped from the sites in accordance with all applicable DOT, DOE, and NRC regulations.

The use of chemically hazardous substances at the Knolls Laboratory and the Kesselring Site is strictly limited to the types and quantities essential for operations. On-site handling of hazardous waste is performed by trained personnel in accordance with applicable regulations and permits. The transportation and disposal of hazardous waste is limited to vendors operating under permits issued by the cognizant Federal and State regulatory agencies. Additionally, all KAPL personnel participate in a training program on the hazards of chemical substances. Other types of solid waste produced on-site, such as cafeteria waste, are disposed of at off-site permitted facilities. Paper, cardboard, glass, wood, and plastic are also segregated for recycling whenever possible. Scrap metals are recycled through local vendors.

Effluent and environmental surveillance programs are conducted at KAPL in accordance with applicable DOE Orders to monitor conformance with applicable Federal and State standards and to confirm that operations have had no adverse impact on the environment or the public. KAPL policy is to minimize releases to levels that are as low as reasonably achievable. A summary of the 2013 routine monitoring data for each KAPL Site is presented and assessed in this report.

Demonstration of compliance with environmental regulations is an integral part of the mission at KAPL and is necessary for each site’s operations. Federal, State, and local regulatory personnel periodically perform site visits and inspections of the Knolls Laboratory, SPRU, and the Kesselring Site. During 2013, sixteen of these visits and/or inspections were performed. Any questions or deficiencies identified during these visits and/or inspections were immediately addressed or promptly corrected.

Areas where historical petroleum or chemical spills have been identified were reported to appropriate regulatory authorities. These areas have been remediated or will be in the future to meet State requirements.

Numerous programs to reduce the potential for environmental effects from KAPL operations have been implemented over the years. At both the Knolls Laboratory and the Kesselring Site, the amount of hazardous waste generated annually has been reduced below the level that necessitates providing waste reduction plans to Federal or State officials.

Section 9.0 of this report provides general information on radiation and radioactivity for those who may not be familiar with radiological terms and concepts.


**Figure 2-1**
**Knolls Site and Kesselring Site Locations in Relation to the Surrounding Communities**

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# 3.0 ENVIRONMENTAL PROGRAM & COMPLIANCE

## 3.1 ENVIRONMENTAL PROGRAM

### Policy

KAPL is committed to conducting operations and activities in a manner that provides and maintains safe and healthful working conditions, protects the environment and surrounding communities, and conserves natural resources. The Knolls Laboratory and the Kesselring Site are committed to environmental excellence through compliance with applicable Federal, State, and local regulations; proactive planning to integrate sound environmental, safety, and health (ESH) principles into every aspect of the work, including hazard identification and risk assessment; and a commitment to waste minimization and pollution prevention.

### Objectives

The objectives of the environmental monitoring programs are to:

- Demonstrate compliance with regulatory requirements,
- Demonstrate operations do not significantly impact the environment,
- Confirm the effectiveness of control methods in preventing increases in environmental radioactivity levels,
- Confirm that the potential radiation exposure received by a member of the public is insignificant compared to the dose received from natural background radioactivity,
- Provide accurate monitoring results to applicable Federal, State, and local officials and to the general public,
- Notify appropriate regulatory agencies of potential compliance concerns, and
- Maintain an accurate record of effluent releases to the environment from KAPL.

### Organization

The Knolls Laboratory and the Kesselring Site have environmental staff professionals to ensure environmental responsibilities are met while also fulfilling the mission of each site. Although the Knolls Laboratory and Kesselring Site each have distinct ESH organizations, there is significant collaboration between the two sites' ESH organizations to optimize personnel expertise, establish uniform practices, and promote the sharing of best practices. These organizations are responsible to identify, interpret, and communicate ESH requirements to KAPL personnel for implementation, assist KAPL organizations in meeting their ESH responsibilities, monitor ESH activities for compliance, and to interface with regulatory agencies and complete required regulatory reports.

## 3.2 ENVIRONMENTAL, SAFETY, AND HEALTH MANAGEMENT SYSTEM

The BMPC Environmental, Safety, and Health Management System documents the management processes and systems to perform work in a manner protective of employees, the public, and the environment, while ensuring regulatory compliance. Environmental performance objectives, performance targets, and deliverables are prepared and reviewed annually. The management processes and systems are used to identify, communicate, implement, assess, and update environmental programs.

## 3.3 ENVIRONMENTAL COMPLIANCE

Demonstration of compliance with environmental regulations is an integral part of the KAPL mission and is necessary for successful site operations. Federal and State regulatory personnel periodically perform site visits and inspections of the Knolls Laboratory, SPRU, and the Kesselring Site. During 2013, sixteen site visits and/or inspections were performed at KAPL and SPRU by Federal, and/or State environmental regulators, or local agencies. Any questions or deficiencies identified during these visits and/or inspections were immediately addressed or promptly corrected. Over ninety periodic environmentally related reports were filed with Federal, State, and local agencies during 2013.

KAPL and SPRU had a total of 33 environmental permits, registrations, or agreements in effect during 2013 that were issued from regulatory agencies for specific facilities or operations. These permits are shown in Table 3-1. New York State General Permits for Stormwater Discharges implemented by KAPL for construction projects one (1) acre or greater, or for work in wetlands or streams are not included in Table 3-1 if their duration was less than one year. However, KAPL has included Municipal Separate Storm Sewer System (MS4) Permits for each site that cover day-to-day operations with regard to stormwater management.

A description of KAPL's compliance with key environmental regulations is provided below. Information on SPRU compliance is provided below, where applicable.

**Clean Water Act (CWA)**

The Federal Clean Water Act and the New York State Environmental Conservation Law (ECL) regulate the chemical components and physical attributes of liquids discharged to the surface waters of the State of New York. Specifically, the Knolls Site and the Kesselring Site effluent and environmental standards are established in site-specific State Pollutant Discharge Elimination System (SPDES) Permits issued by NYSDEC. New York State water quality standards applicable to the Mohawk River and Glowegee Creek are given in Reference (1). NYSDEC renewed the Knolls Site SPDES permit in 2009, which became effective on January 1, 2010. NYSDEC renewed the Kesselring Site SPDES permit in 2013, which became effective on September 1, 2013. Renewed permits are generally in effect for five years.

The constituents of the Knolls Site sewage are regulated by an Outside Users Agreement with the Town of Niskayuna as defined in Reference (2).

During 2013, the Knolls Site did not have any SPDES noncompliance events. However, the Kesselring Site experienced two SPDES noncompliance events as summarized in Table 3-3.

New York State implements the EPA Phase II Stormwater regulations under the SPDES program through two stormwater general permits applicable to KAPL. The most recent versions of these general permits are GP-0-10-001 (General Permit for Stormwater Discharges from Construction Activities) and GP-0-10-002 (Municipal Separate Storm Sewer System, or MS4), which were effective in January and May 2010, respectively. The Construction Stormwater permit requires KAPL and SPRU to process Notices of Intent (NOIs) to participate in the NYSDEC's Stormwater general permitting program for sites disturbing one (1) acre or greater of soil. Participation in this general permit also requires preparation of project-specific storm water pollution prevention plans (SWPPPs). The MS4 general permit was applicable to the KAPL sites because they are Federal facilities and participation required preparation and management of storm water management programs (SWMPs) for both sites. SPRU was not required to obtain the MS4 permit coverage as they are embedded within the Knolls Site boundaries. In addition to certain administrative documentation requirements listed in each permit, the SPDES general permit for construction activities requires an inspection of the project site at least once every seven days. Post-rainfall inspections are required for specific erosion and sediment control practices.

# TABLE 3-1 KAPL AND SPRU ENVIRONMENTAL PERMITS

| Permit Number | Permit Type | Issuing Agency | In Compliance | Expiration Date | Other Information |
|---|---|---|---|---|---|
| **KNOLLS LABORATORY** | | | | | |
| NY0005851 | SPDES[1] | NYSDEC[2] | Yes | 12/31/14 | Site Outfalls |
| 94 3850 | Sanitary | Town of Niskayuna | Yes | None | Outside Users Agreement for Sanitary Sewer Service |
| NYR20A026 | SPDES | NYSDEC | Yes | 04/30/15 | MS4[3] |
| NYR10H590 / NYR10N657 / NYR10T230 | SPDES | NYSDEC | Yes | 01/28/15 | Clean Soil Management Areas II, III, IV |
| NYR10T566 | SPDES | NYSDEC | Yes | 11/07/13[10] | Building A10 SW Utilities |
| 4-4224-00024/00001 | RCRA[4] | NYSDEC | Yes | 07/29/22 | RCRA Waste (EPA ID NY6890008992) |
| 4-4224-00024/00039 Mod 4 | AE[5] | NYSDEC | Yes | None | Heating Boilers and ASGTF[6] |
| 4-443417 | PBSF[7] | NYSDEC | Yes | 08/23/18 | Oil Storage |
| KNOLL-E4-HC-01 | RAE[8] | EPA Region II | Yes | None | Radioactive Materials Laboratory |
| KAPL-2012-003 | RAE | EPA Region II | Yes | None | Bldg D3 Ventilation Duct Removal |
| KAPL-2012-004 | RAE | EPA Region II | Yes | None | Bldg E2/E4 Roof Replacement |
| 49-5-162 | Canal | NYS Canal Corp. | Yes | None | Land Easement Permit |
| C2W130009 | Canal Work | NYS Canal Corp. | Yes | 12/31/13[9] | Mohawk River Sampling |
| C2W130059 | Canal Work | NYS Canal Corp. | Yes | 10/31/13[10] | River water intake maintenance |
| NAN-2013-01176 | NWP Authorization | USACE[11] | Yes | 10/01/14[10] | River water intake maintenance |
| 4-4224-0024/00049 | Water Quality Certification | NYSDEC | Yes | 10/01/14[10] | River water intake maintenance activity |
| **KESSELRING SITE** | | | | | |
| NY 000 5843 | SPDES | NYSDEC | Yes | 08/31/18 | Site Outfalls |
| NYR 20A027 | SPDES | NYSDEC | Yes | 04/30/15 | MS4 |
| NYR 10F015 | SPDES | NYSDEC | Yes | 12/31/20 | Clean Soil Management Area |
| 5-4142-00005/00049 | RCRA | NYSDEC | Yes | 12/12/23 | RCRA Waste (EPA ID NY5890008993) |
| 5-4142-00005/00073 | AFR[12] | NYSDEC | Yes | NA | Air Facility Registration |
| 5-000070 | BCSF[13] | NYSDEC | Yes | 07/19/15 | Chemical Storage |
| 5-414506 | PBSF[7] | NYSDEC | Yes | 08/17/17 | Oil Storage |
| KAPL-788-01 | RAE | EPA Region II | Yes | None | Radiological Work Facility |
| A-05 | Wastewater Sludge | Saratoga County Sewer District #1 | Yes | 09/23/17 | Sewage Treatment Plant (STP) Sludge Disposal |
| GR-042-4 | Grease Trap Disposal | Saratoga County Sewer District #1 | Yes | 06/30/16 | Cafeteria Grease Trap Disposal |
| 5-4142-00005/00088 | Water Quality Certification | NYSDEC | Yes | NA | Security Upgrades Project |
| NAN-2012-00680 | NWP | USACE | Yes | 03/18/17 | Security Upgrades Project |
| **SEPARATIONS PROCESS RESEARCH UNIT** | | | | | |
| 4-4224-00024/00042 | RCRA | NYSDEC | Yes | 09/28/18 | RCRA Waste (EPA ID NYR000096859) |
| NYR10R700 | SPDES | NYSDEC | Yes | NA | Stormwater |
| KAPL-SPRU-PVU-01 | RAE | EPA Region II | Yes | None | Portable Ventilation Units |
| KAPL-SPRU-H2-001 | RAE | EPA Region II | Yes | None | H2 Enclosure Ventilation System |
| KAPL-SPRU-G2-001 | RAE | EPA Region II | Yes | None | G2 Enclosure Ventilation System |

See notes on next page.

Notes for Table 3-1:
(1) State Pollutant Discharge Elimination System
(2) New York State Department of Environmental Conservation
(3) Municipal Separate Storm Sewer System
(4) Resource Conservation and Recovery Act
(5) Air Emission
(6) Advanced Steam Generator Test Facility
(7) Petroleum Bulk Storage Facility
(8) Radionuclide Air Emission
(9) Permit is obtained annually
(10) Permit is obtained as required for the project
(11) U. S. Army Corps of Engineers
(12) Air Facility Registration
(13) Bulk Chemical Storage Facility

**TABLE 3-2 KNOLLS SITE SPDES NONCOMPLIANCES, 2013**

| Permit Type | Outfall | Parameter | # of Permit Exceedances | # of Samples Taken | # of Compliant Samples | Percent Compliance | Date(s) Exceeded | Description/ Solution |
|---|---|---|---|---|---|---|---|---|
| SPDES | NA | NA | None | NA | NA | NA | NA | NA |

**TABLE 3-3 KESSELRING SITE SPDES NONCOMPLIANCES, 2013**

| Permit Type | Outfall | Parameter | # of Permit Exceedances | # of Samples Taken | # of Compliant Samples | Percent Compliance | Date(s) Exceeded | Description/ Solution |
|---|---|---|---|---|---|---|---|---|
| SPDES | 003 | Turbidity | 1 | 346 | 345 | 99% | 04/10/13 | Turbid effluent caused a visible contrast to natural conditions. The manhole was protected from turbid stormwater infiltration upon discovery and the manhole structure was permanently fixed. |
| SPDES | 002 | Total Residual Chlorine | 1 | 167 | 166 | 99% | 07/01/13 | The total residual chlorine sample result was 0.13 mg/l versus the SPDES Permit level of 0.04 mg/l. The system was shutdown upon discovery and the deficiencies for the automated controls of the thermal control valve have been remediated. |

## Clean Air Act (CAA)

The Federal Clean Air Act and its amendments provide the regulatory basis for the protection of ambient air quality; control and reduction in the emissions of the pollutants carbon monoxide, particulate matter, and those compounds that contribute to the formation of ground-level ozone (i.e., volatile organic compounds (VOCs) and nitrogen oxides ($NO_x$)); control and reduction of pollutants likely to increase the risk of death or serious illness (e.g., National Emission Standards for Hazardous Air Pollutants or NESHAPs); control and prevention of accidental releases of regulated hazardous air pollutants or any other extremely hazardous substances; control of the principal contributors to acid rain and other forms of acid deposition (i.e., sulfur dioxide ($SO_2$) and oxides of nitrogen ($NO_x$)); protection of stratospheric ozone; and a mandated Federal permitting program (Title V) for major air emission sources.

The regulatory authority for the majority of the CAA regulations that affect the Knolls Laboratory and the Kesselring Site in New York State has been delegated by the EPA to NYSDEC. Five Federal regulations which currently affect KAPL that have not yet been implemented by the State, but require either report submittals, recordkeeping, and operation and maintenance activity tracking are "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units" (40 CFR 60 – Subpart Dc), "National Emission Standards for Hazardous Air Pollutants Area Sources: Industrial, Commercial, and Institutional Boilers" (40 CFR 63 – Subpart JJJJJJ), "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" (40 CFR 61 – Subpart H), "National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines at Area Sources" (40 CFR 63 – Subpart ZZZZ), and the "Standards of Performance Stationary Compression Ignition Combustion Engines" (40 CFR Part 60 – Subpart IIII). For these five regulations, the EPA retains regulatory authority.

A number of air emission sources at both the Knolls Laboratory and the Kesselring Site, such as site heating boilers, are regulated under the NYSDEC Air Permitting/Registration Program [See Table 3-1], under EPA's 40 CFR 60 Subpart Dc, and under 40 CFR 63 Subpart JJJJJJ. In addition to the heating boilers at the Knolls Laboratory, one of the two Advanced Steam Generator Test Facility (ASGTF) water heaters is also regulated by the EPA under 40 CFR 60 Subpart Dc. Both the heating boilers and the ASGTF water heaters are also regulated under the NYSDEC Air Permitting Program.

The air permit for the Knolls Laboratory heating boilers has Federally enforceable capping provisions that allow the heating boilers to be classified as synthetic minor sources. As such, the Knolls Laboratory does not require a Title V facility permit, which normally applies to major sources under the CAA.

The Kesselring Site was issued a NYSDEC Air Facility Registration for the two boiler house stacks. Using the NYSDEC "Cap-by-Rule" provisions, the Kesselring Site heating boilers are also classified as synthetic minor sources and do not require a Title V facility permit or a State Facility Permit.

The air emission sources listed in Table 3-1 have been operated in accordance with their permit or facility registration conditions.

Other nonradioactive air emission sources that do not require State permits or registrations at the KAPL sites either come under an exemption for ventilating and exhausts from laboratory operations, NESHAPs minor source exemptions presently in effect, or are considered as exempt or trivial activities under New York State regulations.

The EPA, under 40 CFR 61 Subpart H, regulates radionuclide air emission sources at the Knolls Site and the Kesselring Site. During 2013, the maximally exposed individual effective dose equivalent, calculated using the EPA computer code CAP88-PC, was less than 0.1 mrem for the Knolls Laboratory, including SPRU, and Kesselring Site, which is less than 1% of the 10 mrem/year EPA standard. Annual radionuclide air emission reports are provided to the EPA, as required by the regulations, and also to NYSDEC.

The SPRU project experienced an unplanned release of airborne radioactivity during the open-air demolition of Building H2 on September 29, 2010. The DOE conducted a Type B accident investigation. As a result of the EPA's investigation into the event, both SPRU and the Knolls Laboratory were determined not to be in compliance with the radionuclide NESHAPS regulations, and EPA issued a

Compliance Order on Consent in March 2012 to the DOE. On June 5, 2012, the EPA informed DOE of EPA's conclusion that the Knolls Site was back in compliance with the radionuclide NESHAPs requlations. Final corrective actions required by the Consent Order were completed on February 28, 2013.

**Resource Conservation and Recovery Act (RCRA)**

The Federal Resource Conservation and Recovery Act and the New York State ECL were enacted to address the safe disposal of municipal and industrial solid and hazardous waste. RCRA, like most environmental legislation, encourages States to develop their own hazardous waste programs as an alternative to direct implementation of the Federal program. To this end, the EPA has delegated its authority to NYSDEC for all aspects of RCRA, with the exception of a few specific portions associated with the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA.

During 2013, the Knolls Laboratory and the Kesselring Site continued to operate as both hazardous waste generators and permitted storage facilities. In this latter instance, the Knolls Laboratory and the Kesselring Site received NYSDEC, 6 NYCRR Part 373, hazardous waste storage permits in July 1998 and June 1995, respectively. As such, each KAPL site must follow specific requirements for handling/accumulation of hazardous waste under applicable New York State regulations as well as the conditions for storage of such waste under their respective State-issued hazardous waste management permits. Hazardous waste management permits are generally in effect for ten years. The Knolls Laboratory permit was renewed on July 30, 2012. The Kesselring Site permit was renewed on December 13, 2013. Representatives from EPA inspect the KAPL sites annually for compliance.

SPRU personnel and contractors manage universal/hazardous/mixed waste in accordance with the 6 NYCRR Part 373 and Part 374-3 regulations and ship waste to permitted TSDFs within the appropriate timeframes. During 2013, SPRU continued to operate as a small quantity hazardous waste generator.

**RCRA Corrective Action Program**

The 1984 HSWA to RCRA expanded EPA's authority to require Treatment, Storage and/or Disposal Facilities (TSDFs) to conduct corrective action for releases from a facility. Under this section of RCRA, the EPA or an authorized State must require corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a TSDF seeking a permit under RCRA, regardless of the time at which the waste was placed in such units. The regulations implementing this section of RCRA define the term "solid waste management unit (SWMU)" to include: any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.

NYSDEC has been granted authority by the EPA to manage their own RCRA 3004(u) corrective action program via the New York State ECL. The KAPL 6 NYCRR Part 373 hazardous waste permits require each KAPL site to pursue facility characterization and corrective action, if necessary. In addition to the SWMUs included in each of the permits, New York State has also established "areas of concern" or AOCs. An AOC is an area which is not at this time known to be a SWMU, where hazardous waste and/or hazardous constituents are present, or are suspected to be present as a result of a release from the facility. The term includes areas of potential or suspected contamination as well as actual contamination. Such area(s) may require study and a determination of what, if any, corrective action may be necessary.

The Knolls Laboratory and the Kesselring Site are performing RCRA corrective action efforts under the oversight of NYSDEC. Each KAPL site has several areas where historical releases of hazardous chemicals require sampling and potential remedial action. Reports of sample analytical results and actions taken are submitted for NYSDEC approval as they are accomplished, in accordance with established schedules.

SPRU performs RCRA corrective actions in accordance with DOE-EM 6 NYCRR Part 373 Permit (permit #4-4224-00024/00042) under NYSDEC's authority. This permit is a Corrective Action Only permit, meaning that there are no treatment, storage or disposal provisions included therein.

**Federal Facility Compliance Act (FFCA)**

The Federal Facility Compliance Act (FFCA) was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act (SWDA). The FFCA applied certain requirements and sanctions of RCRA to Federal facilities. In short, the FFCA waives sovereign immunity for Federal facilities from all civil and administrative penalties and fines; this includes waivers for both coercive and punitive sanctions for violations of the SWDA. Relative to mixed waste (mixed waste is waste that contains both hazardous (regulated by EPA/NYSDEC) and radioactive material (regulated by DOE)), the FFCA mandated the development and Federal/State approval of Site Treatment Plans (STPs), that contain schedules for developing treatment capabilities and for treating mixed wastes subject to the Land Disposal Restrictions (LDR) of 40 CFR 268 and 6 NYCRR 376.

The U.S. DOE Naval Reactors Laboratory Field Office (NRLFO) and the NYSDEC signed Administrative Consent Orders in October 1995 to establish commitments regarding compliance with the approved STPs for mixed wastes stored and generated at the Knolls Laboratory and the Kesselring Site. In compliance with the Orders, the STPs are updated annually and issued to the NYSDEC by April 30 each year. NRLFO and NYSDEC terminated the Kesselring Site's Administrative Consent Order in August 2009 because the requirements and milestones established in the Kesselring Site STP had all been completed. The Knolls Laboratory STP has met all of its milestones with the exception of the mixed transuranic remote handled waste stream (which has yet to be generated). The SPRU RCRA Permit authorizes transfer of small amounts of mixed (i.e., containing hazardous and radioactive components) waste to the Knolls Laboratory permitted area until shipped off-site by SPRU in accordance with DOE-EM's STP.

**Waste Minimization, Pollution Prevention and Recycling Programs**

The KAPL waste minimization and pollution prevention program promotes pollution prevention and waste minimization by encouraging employees to reduce the initial use of hazardous materials, energy, water, and other resources while protecting existing resources through conservation and more efficient use. The program focuses mainly on process efficiency improvements, source reduction, inventory control, preventive maintenance, improved housekeeping, recycling, and increasing employee awareness of, and participation in, pollution prevention.

The goal of the program is to minimize the quantity and toxicity of waste generated at its source and, if waste is generated, to ensure that the treatment and disposal method used minimizes the present and future threat to people and the environment. The program consists of the following elements:

- Control of chemical acquisitions, including type and quantity;
- Maximized use of on-hand chemicals;
- Minimized production of process wastes (Source Reduction); and
- Process evaluation/modification.

KAPL ensures pollution prevention strategies are met by reviewing chemical purchases and major construction projects to incorporate source reduction strategies for environmentally hazardous substances.

Consistent with the ESH Management System, which serves as the foundation of KAPL's environmental management program, KAPL has established and implemented a sustainable acquisition program.

Progress in sustainable acquisition is reported annually to the DOE via the Consolidated Energy Data Report (CEDR). Sustainable acquisition maximizes the amounts of material procured that contain recycled material. Environmentally preferable items reported in the KAPL program include but are not limited to: paper and paper products, vehicular products (e.g., engine coolants, oils), construction (e.g., insulation, carpet, concrete, paint) and transportation products (e.g., traffic barricades, traffic cones), park and recreation products, landscaping products, non-paper office products (e.g., binders, toner cartridges, office furniture), and miscellaneous products (e.g., pallets, sorbents, and industrial drums).

KAPL also maintains an extensive recycling program which includes office paper, cardboard, newspapers, telephone books, printer cartridges, scrap metal, batteries, scrap lead, cooking oil, aluminum cans, asphalt, concrete, tires, oil, light bulbs, circuit boards, computer equipment, magnetic media, precious metals, and wood. KAPL recycled approximately 34% of its municipal waste stream in 2013.

SPRU complied with DOE Order 450.1, "Environmental Protection Program" that contains DOE Sustainable Environmental Stewardship goals, which include the goals to reduce or eliminate the acquisition, use, and release of toxic and hazardous chemicals and materials, and to maximize the acquisition and use of environmentally preferable products in the conduct of operations.

**Toxic Substances Control Act (TSCA)**

The U.S. Congress enacted the Toxic Substances Control Act (TSCA) in 1976. TSCA authorizes EPA to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. Unlike many other environmental laws, which generally govern discharge of substances, TSCA requires that the health and environmental effects be reviewed prior to a new chemical substance being manufactured for commercial use. TSCA, therefore, closes the gap in environmental regulations by allowing the EPA to prevent toxic problems rather than simply reacting to them after discharge. However, because KAPL does not manufacture chemicals or materials for commercial use, a majority of the implementing TSCA regulations do not apply.

Polychlorinated biphenyls (PCBs) are regulated as a toxic substance under TSCA by means of 40 CFR Part 761. PCBs were used prior to 1979 mainly as a dielectric fluid in electrical equipment such as transformers and capacitors. PCBs were also added to certain surface coatings and other non-liquid materials due to their heat and chemical resistance. KAPL has identified PCBs in materials such as small electrical transformers, fluorescent light ballasts, applied dried paints, lubricants/machine oils, and electrical cable insulation. KAPL has removed all large PCB transformers from its sites and continues to remove and replace PCB fluorescent light ballasts, where practical. Additionally, KAPL employs strict controls for removal, storage, and disposal of its remaining PCB containing items. Similarly, SPRU manages PCBs in accordance with the requirements of TSCA under 40 CFR Part 761.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**

The Federal Comprehensive Environmental Response, Compensation, and Liability Act, commonly referred to as CERCLA or Superfund, was designed to respond to situations involving the past disposal of hazardous substances. As such, it complements RCRA, which regulates on-going hazardous waste handling and disposal.

The National Priorities List is an important facet of CERCLA's response procedures and is updated annually to list sites warranting evaluation and/or cleanup under CERCLA. EPA Region II, in May 1994, designated both the Knolls Laboratory and the Kesselring Site as Site Evaluation Accomplished following a series of studies and correspondence related to a Preliminary Assessment and Site Inspection Report prepared in accordance with CERCLA Section 120. As a result, neither KAPL site warranted inclusion on the National Priorities List.

**Emergency Planning and Community Right-to-Know Act (EPCRA)**

The Federal Emergency Planning and Community Right-to-Know Act establishes authorities for emergency planning and preparedness, emergency release notification reporting, community right-to-know reporting, and toxic chemical release reporting. Under the provisions of this Act covered facilities must provide the following information to State and local entities: the name of the individual who will function as a Facility Emergency Coordinator, notice that certain applicable substances (e.g., extremely hazardous substances on-site above certain threshold planning quantities) are present at that facility and, when required, report releases of those substances and other listed hazardous substances in excess of certain reportable quantities (RQ). Additionally, EPCRA requires that facilities prepare and submit, or retain on file, the information listed in the following sections below which are codified under 40 CFR Parts 370 and 372:

- §302-303 – Provide initial notification to State Emergency Response Commission (SERC), Local Emergency Planning Committees (LEPC), and local fire departments that the facility is subject to the emergency planning requirements under EPCRA.
- §304 – Facilities must immediately notify the LEPC and the SERC if there is a release to the environment of a hazardous substance that is equal to or exceeds the minimum reportable quantity set in the regulations.
- §311 – The submission of material safety data sheets (MSDSs) for extremely hazardous substances (EHS) stored on-site in quantities greater than the threshold planning quantity (TPQ) or any substance on-site greater than 10,000 pounds for which a potential exposure to an employee exists.
- §312 – Complete an annual Tier Two Inventory Report for EHS and hazardous chemicals at each site in excess of specified quantities during the previous calendar year. The information is submitted to the SERC, Local Emergency Planning Committees, and local fire departments for emergency planning purposes.
- §313 – Complete an annual evaluation of activities associated with the manufacturing, processing, or otherwise use of any of the listed toxic chemicals above the designated activity thresholds and where necessary prepare a Toxics Release Inventory (TRI) report for submittal to EPA.

The status summary of Knolls Laboratory, Kesselring Site, and SPRU site EPCRA Reporting is shown in Tables 3-4 through 3-5. There were no EPCRA reportable releases from KAPL or SPRU in 2013, nor were either of the KAPL sites nor SPRU required to submit toxic release information reports under Section 313 for the 2013 reporting year.

## TABLE 3-4 STATUS OF KNOLLS LABORATORY & KESSELRING SITE EPCRA REPORTING

| *EPCRA Section* | *Description of Reporting* | *Status* |
|---|---|---|
| EPCRA Sec. 302-303 | Planning Notification | No Notifications required for calendar year |
| EPCRA Sec. 304 | Extremely Hazardous Substance Release Notification | No Reportable Releases |
| EPCRA Sec. 311-312 | MSDS/Chemical Inventory | No MSDS notifications required for calendar year 2013<br>Chemical Inventory (Tier Two) Reports for calendar year 2013 filed |
| EPCRA Sec. 313 | TRI Reporting | Not Required |

## TABLE 3-5 STATUS OF SPRU EPCRA REPORTING

| *EPCRA Section* | *Description of Reporting* | *Status* |
|---|---|---|
| EPCRA Sec. 302-303 | Planning Notification | No Notifications required for calendar year |
| EPCRA Sec. 304 | Extremely Hazardous Substance Release Notification | No Reportable Releases |
| EPCRA Sec. 311-312 | MSDS/Chemical Inventory | No Notifications required for calendar year 2013 |
| EPCRA Sec. 313 | TRI Reporting | Not Required |

### Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act gives EPA authority to regulate the field use of pesticides, which EPA implements through a State-administered certification program. Authorized KAPL personnel applying pesticides such as cooling tower addition chemicals keep a daily use log for every application of a general use pesticide. Annual reports are filed and provided to NYSDEC by the certified applicator/technician for all pesticides applied during the previous year. Any such chemical applied by a subcontractor licensed commercial application business or under their guidance is recorded and reported by the subcontractor directly.

### National Environmental Policy Act (NEPA)

Significant construction, renovation, demolition, decommissioning, decontamination and remediation activities are reviewed for their impact on the environment under the National Environmental Policy Act (NEPA) requirements as provided by the Department of Energy. Other projects or capital equipment that have the potential for creating new emissions to the environment also receive a NEPA evaluation. Categorical Exclusions (CXs) and all NEPA documentation for the NNPP Sites including the Knolls Laboratory and the Kesselring Site are posted online at *www.NNPP-NEPA.US*. This website is linked to the U.S. Department of Energy website located at *www.nepa.energy.gov*.

# 4.0 KNOLLS LABORATORY ENVIRONMENTAL MONITORING

## 4.1 SITE DESCRIPTION

The Knolls Site is located in the Town of Niskayuna, New York, approximately two miles (3.2 kilometers) east of the City of Schenectady. The Knolls Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Laboratory include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, a small municipal park, and suburban residential areas.

The climate in the region of the Knolls Site is primarily continental in character, but is subjected to some modification from the maritime climate that prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally severe. Maximum temperatures during the colder winter months often are below freezing and nighttime low temperatures frequently drop to $10^0$ F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 59 inches per year. The mean annual precipitation for the region is approximately 39 inches per year. Westerly winds (W to NW) predominate, and a secondary maximum occurs about the south-southeast direction.

The Knolls Site is located in the Mohawk River Valley at an elevation of approximately 330 feet above mean sea level. Monitoring wells and soil/bedrock borings in the vicinity of the Knolls Site show that unconsolidated materials, consisting mainly of glacial deposits, overlie bedrock. The depth of bedrock beneath the site generally ranges between 10 and 70 feet. Rock outcrops are visible on both banks of the Mohawk River between the Rexford Bridge, approximately two miles upstream, and a point about three quarters of a mile downstream from the Knolls Site. The outcrops are shales and sandstones of the Ordovician-age Schenectady Formation. These rocks are characteristically non-porous and impermeable, and form poor aquifers. The bedrock structure is relatively simple. Over 90 percent of the entire County is underlain by the Schenectady Formation, a series of alternating beds of shale, sandstone, and grit about 2,000 feet thick, which dip gently west and southwest. The Snake Hill formation is exposed along both sides of the Mohawk River near the dam at Lock 7, downstream from the Knolls Site. This formation consists of a considerable thickness of dark gray to black, bluish, and greenish-gray shale. It is the only formation in Schenectady County that is strongly folded, having been thrust westward against and over the Schenectady Formation.

The glacial deposits consist almost entirely of glacial till. The glacial till at the Knolls Site is clay rich, dense, compact, and is known locally as hardpan. The depth of the till beneath the site ranges from 0 to 70 feet. The till appears a grayish-blue color but in the upper twelve feet portion it has been weathered to a yellowish brown color. Within the till, occasional lenses of graded material, usually fine sand, exist. The till is almost entirely impermeable except for a few lenses of sand, which are capable of transmitting water. These lenses are small in size and isolated from one another based on drilling records and on-site monitoring well performance. Overlying the till in the eastern portion of the site are glacial lake sequences (silts and clays) and thin, discontinuous ice-contact deposits (sands and gravels). The ice-contact deposits are capable of transmitting water but their limited extent diminishes the potential for yielding useable water volumes.

The Knolls Site is located adjacent to the Mohawk River that serves as the main watercourse for the Mohawk River Drainage Basin, covering an area of 3,450 square miles. The river flows eastward to where it joins the Hudson River in Cohoes, N.Y. The average flow rate of the Mohawk River is 5,895 cubic feet per second (cfs) and the lowest recorded seven-day average flow is 458 cfs during August 1995. Three small streams that receive drainage from the Knolls Site are tributary to the Mohawk

River. The East Boundary Stream is located between the Knolls Site closed landfill and the closed Town of Niskayuna landfill. The East Boundary Stream also receives runoff from a nearby housing development and roadway. The Midline Stream originates on-site and drains the central portion of the site. The West Boundary Stream is located adjacent to the Knolls Site on General Electric (GE) Global Research Center property. This stream receives some surface water runoff from a tributary ditch from the site. A fourth surface water drainage-way, located on the west side of the closed Knolls Site landfill, is referred to as the West Landfill Stream. This drainage-way does not directly discharge to the Mohawk River and rarely has an observable flow. The flow in all of these streams becomes extremely low to nonexistent during the late summer/early fall. These streams are not accessible to the public, except at the point where they each meet the Mohawk River, nor are they suitable for fishing or swimming.

The groundwater within the immediate vicinity of the Knolls Site is very limited due to both low porosity and permeability of the till which prohibits the development of the groundwater as a potable water supply. As such there are no drinking water wells on-site. There are no underlying principal or primary bedrock or overburden aquifers. Water for site operations involving potable and noncontact cooling use is obtained from the Schenectady and Niskayuna Municipal Water Systems. The majority of water for noncontact cooling at the Knolls Laboratory is obtained from the Mohawk River.

The Mohawk River is classified by the New York State Department of Environmental Conservation (NYSDEC) as a Class A stream. The best usages of Class A waters are considered to be: a source of water for drinking, culinary or food processing purposes, primary and secondary contact recreation, and fishing. The waters shall be suitable for fish propagation and survival. The Knolls Site discharges water from its various operations within the concentration, mass loading, and flow limits set by the SPDES Permit, Reference (3).

## 4.2 LIQUID EFFLUENT MONITORING

### 4.2.1 Sources

**Nonradiological:** The principal sources of effluent water are:

1. *Sewage Pumping Station* - Knolls Site sewage is pumped to the Town of Niskayuna sewage treatment facility. The untreated sewage consists primarily of wastewater from restrooms, cafeteria services, and janitorial sinks. A small portion may also consist of dilute nonhazardous laboratory rinse water, dilute nonhazardous analytical waste, environmental samples, and ammoniated or phosphated process water.

2. *Cooling Towers* - Cooling water, used mainly for central air conditioning, is treated to maintain a pH range of 7.5 to 8.2, to minimize scale buildup, to prevent corrosion of system materials, and to inhibit the growth of algae and slime. The towers are periodically blown down to control chemistry and some are drained to prevent freezing in the winter. The water drained from the towers is discharged to the Mohawk River.

3. *Site Boiler Plant* - Site boiler water is chemically treated, softened and de-alkalized water. Operations that result in releases are (1) periodic blowdowns to control boiler chemistry and (2) ion exchange resin regeneration effluent from the softener and the de-alkalizer systems. Water generated by the blowdown and de-alkalizer regeneration operations are neutralized and allowed to cool before being discharged to the Mohawk River.

4. *Noncontact Cooling Water* - Mohawk River water and Site Service Water (municipal water supply) are used as noncontact cooling media for several heat exchangers and are discharged to the Mohawk River.

5. *Process Water* - Treated/untreated wastewater, primarily from the river water strainer system, is generated on-site. Process water treatment typically consists of one or more of the following processes: sedimentation, filtration, ion exchange, activated carbon adsorption and/or neutralization before being discharged to the Mohawk River.

6. *Site Drainage Water* - Stormwater and groundwater also make up a portion of the liquid effluent to the Mohawk River.

Approximate flows and chemical characteristics of the discharges to the Mohawk River (Items 2-6) were incorporated into the SPDES Permit application and Permit, Reference (3).

**Radiological:** Historically, the concentrations of radioactivity in liquids released from the Knolls Laboratory have always been below all applicable limits. The small volume of liquids generated from current laboratory operations that may contain radioactivity are collected for shipment off-site in an absorbed form to an approved disposal facility. This minimizes the quantities of radioactivity released from the Knolls Laboratory.

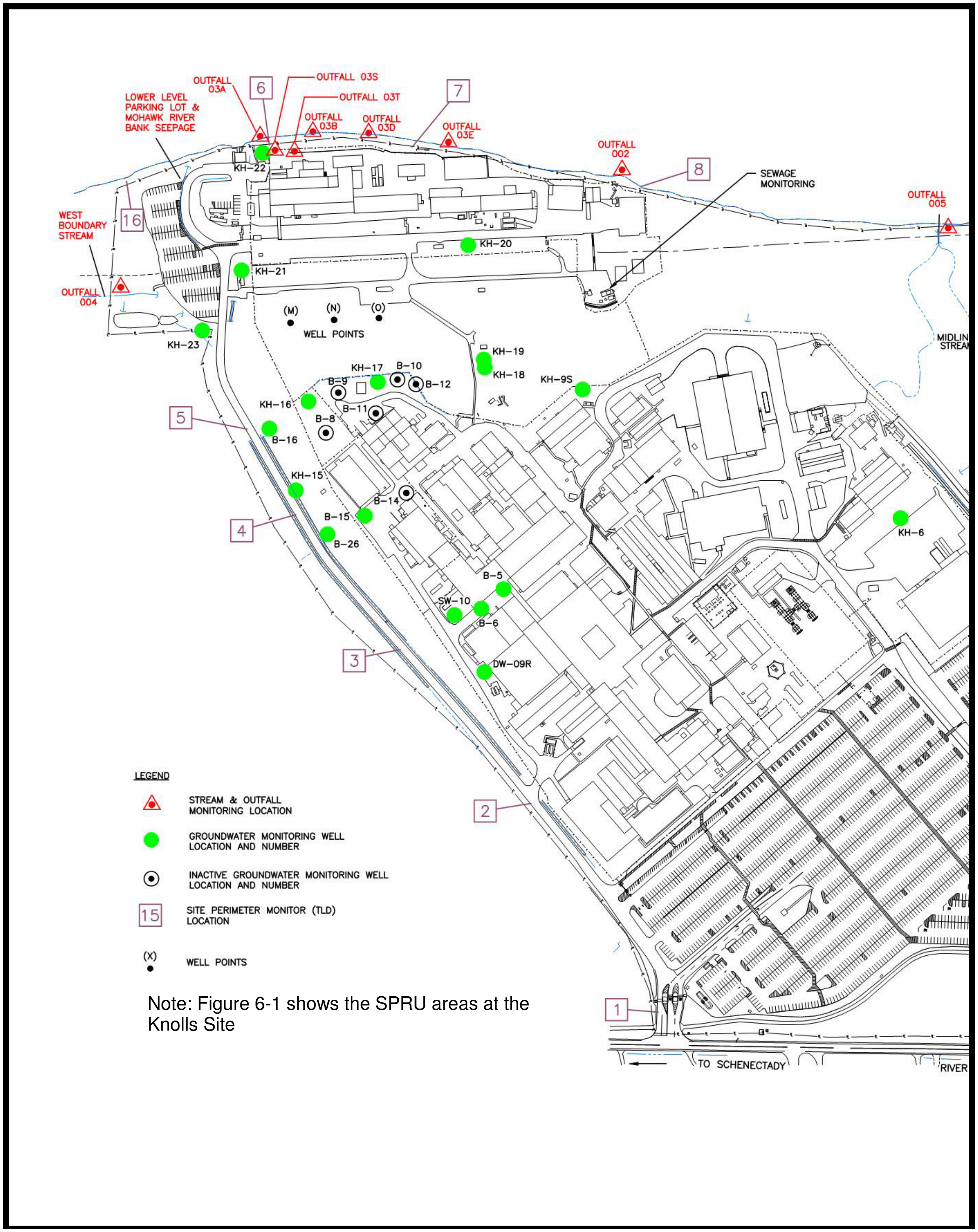
The small amounts of groundwater and stormwater that runoff from SPRU contain low level residual radioactivity from operations conducted during the 1950s and 1960s and are released in the site drainage water. The principal radioactive constituents released to the Mohawk River from all sources are the longer lived fission products strontium-90 and cesium-137.

### 4.2.2 Effluent Monitoring

**Nonradiological:** The Knolls Site sanitary sewage is pumped to the Town of Niskayuna Publicly Owned Treatment Works (POTW) in accordance with an Outside Users Agreement, Reference (2). The Agreement specifies the parameters and sampling frequency for the untreated sewage. The minimum sampling frequency is monthly for chemical constituents; while flow and pH measurements are required daily. Typically, a twenty-four hour flow-composited sample for chemical constituents is collected weekly. All monitoring data are averaged, with the exception of pH for which the maximum and minimum values for the month are reported, and then provided in a monthly report to the Town. The sewage pumping station is equipped with a pH alarm that shuts off the main pumps, when the alarm set points are exceeded. Sewage flow is then allowed to passively overflow into a holding tank.

The Knolls Site water discharged to the Mohawk River is regulated by a SPDES Permit, Reference (3). The SPDES Permit specifies the required sampling locations, parameters, and minimum sampling frequencies. The SPDES Permit was renewed during 2009 and the renewal became effective on January 1, 2010. The term of the permit is five years and must be renewed by December 31, 2014.

Liquid effluent from the Knolls Site enters the Mohawk River through a submerged outfall (Outfall 002), four small surface outfalls (Outfalls 03A, 03B, 03D, and 03E), and three natural stormwater streams (Outfalls 004, 005, and 006) as shown in Figure 4-1.




Note: Figure 6-1 shows the SPRU areas at the Knolls Site

**Figure 4-1**
**Knolls Site, Niskayuna, New York**
**Stream and Outfall, Groundwater, and Perimeter TLD Monitoring Locations**

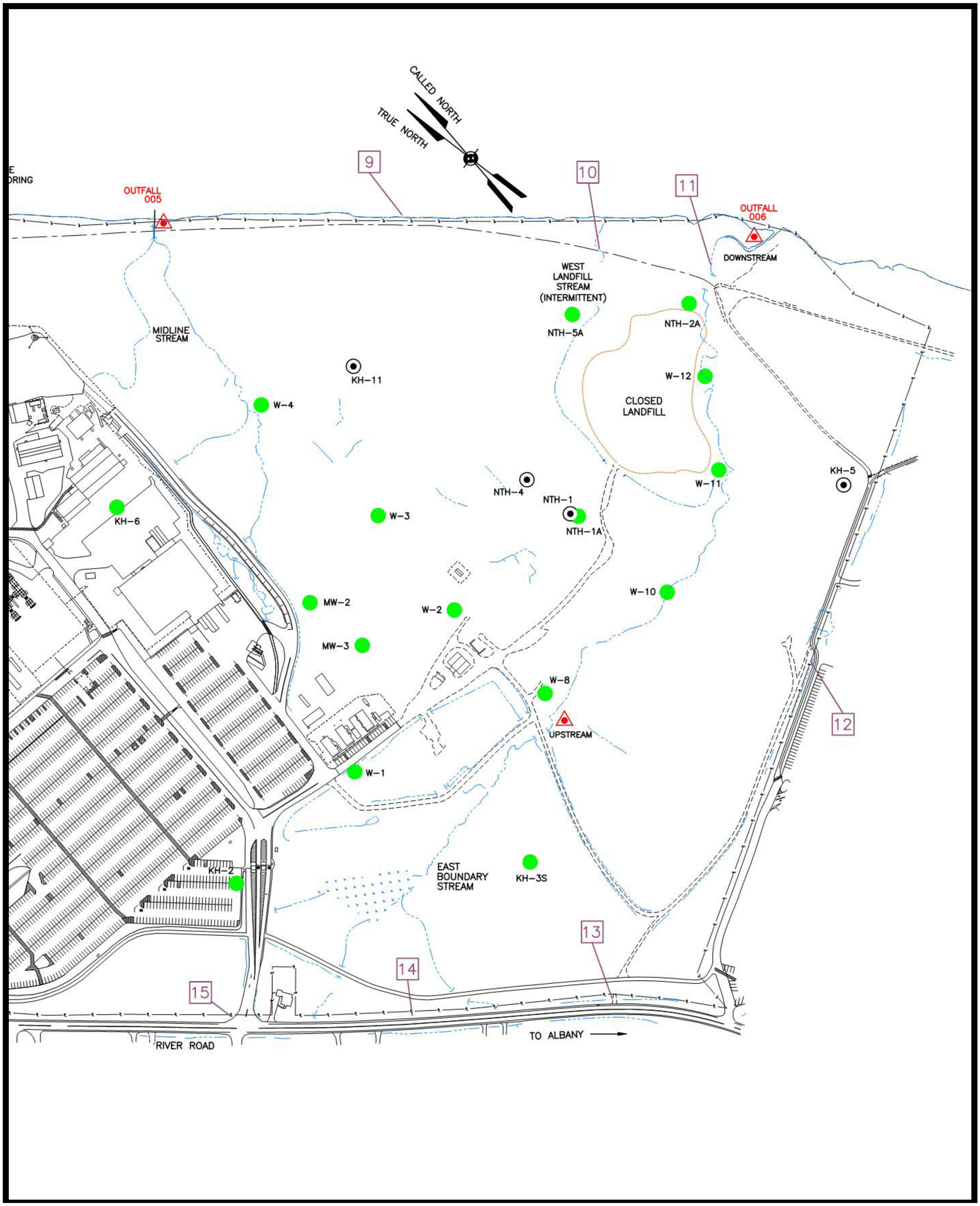



**Figure 4-1, Continued**
**Knolls Site, Niskayuna, New York**
**Stream and Outfall, Groundwater, and Perimeter TLD Monitoring Locations**

Outfall 002 discharges noncontact cooling water, process water, stormwater, and groundwater through a submerged drain line directly to the Mohawk River. The Outfall 002 monitoring station consists of a continuous temperature monitor and a Parshall flume which provides for the continuous measurement and recording of effluent flow rate and total flow. In addition, weekly grab samples are taken at Outfall 002 and analyzed for the constituents specified in the SPDES Permit, including copper when the Copper Ion Generator is operating (see below).

Outfalls 03B and 03D discharge Mohawk River water used for once-through noncontact cooling, stormwater, and groundwater. Monthly grab samples for flow and temperature are taken at these outfalls in compliance with the SPDES permit, in addition to continuous monitoring performed on a voluntary basis for these parameters. A Copper Ion Generator is used to inhibit zebra mussel attachment to noncontact cooling water system piping when the river water temperature is in excess of $50^{o}$ Fahrenheit. As such, grab samples are obtained at 03B and 03D on a weekly basis for copper when the Copper Ion Generator is operating, and on a monthly basis for other chemical constituent analyses.

The river water used for noncontact cooling must be strained to remove large particles to prevent clogging of the Knolls Laboratory heat exchangers and instrumentation lines. A settling tank removes the sediment from the river water pump strainer backwash effluent. The inlet and outlet of the settling tank have been designated as Outfalls 03S and 03T, respectively. The discharge from 03T is directed to Outfall 03B. The required sampling frequency for this tank is twice per month.

Outfalls 03A and 03E discharge only groundwater and stormwater as allowed by the SPDES Permit. These outfalls are monitored quarterly utilizing a flow estimate and grab sample for pH and chemical constituent analyses. All monitoring is in accordance with the SPDES Permit.

Three Knolls Site stormwater outfalls, designated as 004, 005, and 006, are commonly referred to as the West Boundary Stream Ditch, Midline Stream, and East Boundary Stream, respectively. The flows in these surface water streams are intermittent, and the streams are sampled quarterly for SPDES parameters, when possible. Additionally, the East Boundary Stream is sampled biannually in accordance with the Knolls Site Landfill Post-Closure Monitoring Program. The sampling location for Outfall 004 is a ditch that is on Knolls Site property that drains to the West Boundary Stream.

The West Landfill Stream is not part of the SPDES program but is monitored in accordance with the Knolls Site Landfill Post-Closure Monitoring Program. Flow in this drainage-way is rare, and it is sampled biannually for chemical parameters when flow exists during the sampling event.

The current SPDES permit requires Whole Effluent Toxicity (WET) testing for Outfall 002 every five years; specifically in the years ending with a "2" or a "7." The next required round of WET testing will occur in 2017.

**Radiological:** The Outfall 002 Monitoring station includes a system for the collection of samples that are proportional to effluent flow. A monthly composite sample is prepared from the proportional samples and analyzed monthly for radioactivity. Monthly grab samples are taken at Outfalls 03A, 03B, 03D, 03E, 004, 005, 006, Upper East Boundary Stream, and West Landfill Stream. Background grab samples are also taken monthly at the Upper West Boundary Stream, Site Service Water, and Mohawk River Cooling Water Intake. Seepage samples are also collected from the Mohawk River Bank and near the Lower Level Parking Lot. Beginning in May of 2011, monthly split samples of Outfall 002 and 004 are provided to the New York State Department of Health (NYSDOH).

The sanitary sewage pumped to the Town of Niskayuna POTW is required to be sampled a minimum of quarterly for radioactivity in accordance with the Outside Users Agreement. However, typically, weekly twenty-four hour composite samples are obtained and then composited into quarterly samples and analyzed for radioactivity.

### 4.2.3 Effluent Analyses

**Nonradiological:** Periodic grab samples collected from Outfalls 002, 03A, 03B, 03D, 03E, 03S, 03T, 004, 005, and 006 are analyzed for the chemical constituents listed in Reference (3). Samples from various outfalls may be analyzed for additional parameters for informational purposes only and are presented in the appropriate data tables. Twenty-four hour flow-composited samples of the sewage pumped to the Town of Niskayuna are collected and analyzed as required by Reference (2).

**Radiological:** The monthly composite sample collected at the Outfall 002 is analyzed for (1) strontium-90 by radiochemical separation and subsequent beta counting, (2) cesium-137 and other gamma-emitting radionuclides by gamma spectrometry, (3) tritium by liquid scintillation counting, and (4) gross alpha and gross beta radioactivity by direct sample evaporation and subsequent alpha and beta counting. Samples from the remaining outfalls are analyzed for gross alpha and gross beta radioactivity. Analyses for strontium-90 and cesium-137 are routinely performed for Outfalls 03A, 03D, 03E, 004, 005, 006, Lower Level Parking Lot Seepage, and Mohawk River Bank Seepage. For Outfall 03B and the West Landfill Stream, analysis for strontium-90, cesium-137, and other gamma-emitting radionuclides are performed if the gross beta radioactivity exceeds 10 pCi/l.

The quarterly composite sample of the sanitary sewage effluent to the Town of Niskayuna POTW is analyzed for strontium-90, cesium-137, cobalt-60, tritium, and uranium. Weekly samples are analyzed for gross alpha and beta radioactivity.

### 4.2.4 Assessment

**Nonradiological:** The analytical results for the chemical constituents, flow, and pH monitored in the Knolls Site sewage effluent during 2013 are summarized in Table 4-1. The Knolls Site average effluent results show that the Knolls Site has operated within all parameters specified in the Outside Users Agreement, Reference (2).

The analytical results for the chemical constituents, flow, and temperature monitored in the Knolls Site liquid effluent during 2013 are summarized in Table 4-2. The annual average values of all parameters were within the appropriate effluent permit limits or standards where standards exist for Outfalls 002, 03A, 03B, 03D, 03E, 03S, and 03T. This data was reported to NYSDEC as appropriate in the monthly SPDES Discharge Monitoring Reports.

The Mohawk River is voluntarily monitored for chloride at two locations. The data for the upstream and downstream locations are presented in Table 4-3. The Knolls Site SPDES Permit designates the Mohawk River intake as Outfall 001, and requires it to be monitored for flow, pH, total suspended solids, and copper (when the Copper Ion Generator is operating). The intake data is used to determine net limits and to determine appropriate pH ranges for the outfalls or for information. Data are summarized in Table 4-2.

The Knolls Site SPDES Permit requires the surface water streams, West Boundary Stream Ditch, Midline Stream, and East Boundary Stream, to be monitored quarterly for five parameters, when flow exists in these streams. The analytical results for required chemical constituents, flow, and pH were within the specified limits. Additional parameters are monitored voluntarily. These results are summarized in Tables 4-4 and 4-5.

Nonradioactive liquid effluent monitoring data are reported monthly, as required in Reference (3). The monthly SPDES Discharge Monitoring Reports are available for public viewing at the Niskayuna Branch of the Schenectady County Public Library.

## TABLE 4-1 CHEMICAL CONSTITUENTS IN KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT, 2013

| | Value[1] Knolls Laboratory Sewage Lift Station | | | | | |
|---|---|---|---|---|---|---|
| **Parameter (Units)** | **Number of Samples** | **Minimum** | **Maximum** | **Average[2]** | **Users Agreement[3]** | **Percent of Limit[4]** |
| **Outside Users Agreement #94 3850 Requirements (Reference 2)** | | | | | | |
| Flow (GPD) | 365 | 2,344 | 48,216 | 21,316[5] | 45,000 | 47 |
| pH (SU) | 1,216 | 7.0 | 9.0 | --- | 6.0-9.5[6] | --- |
| Biochemical Oxygen Demand (mg/l) | 52 | 142 | 916 | 331 | 700 | 47 |
| Chemical Oxygen Demand (mg/l) | 52 | 397 | 1,560 | 774 | 1,800 | 43 |
| Total Suspended Solids (mg/l) | 52 | 73 | 1,500 | 396 | 1,600 | 25 |
| Ammonia (as N) (mg/l) | 52 | 29.3 | 178 | 114 | 200 | 57 |
| Nitrate (as N) (mg/l) | 52 | <0.02 | 0.93 | <0.23 | 4 | <6 |
| Nitrite (as N) (mg/l) | 52 | <0.01 | 0.51 | <0.07 | 4 | <2 |
| Total Kjeldal Nitrogen (as N) (mg/l) | 52 | 31.4 | 177 | 137 | 250 | 55 |
| Total Organic Nitrogen (as N) (mg/l) | 52 | <1 | 59.0 | <23.1 | 175 | <13 |
| Total Nitrogen[7] (as N) (mg/l) | 52 | 32 | 177 | 136.9 | 250 | 55 |
| Phosphate (as P) (mg/l) | 52 | 9.2 | 18.8 | 13.1 | 30 | 44 |
| **Additional Parameters Monitored** | | | | | | |
| Oil & Grease (mg/l) | 52 | 15.2 | 426[9] | 46.1 | 100[8] | 46 |

Notes:

(1) A value preceded by "<" is less than the practical quantitation limit.
(2) Average values preceded by "<" contain at least one less than practical quantitation limit value in the average.
(3) Outside Users Agreement allows for monthly averaging of data unless noted.
(4) Percent of limit for the average value, unless otherwise noted.
(5) The average of the monthly flows for the year that were reported to the Town of Niskayuna is used for this value.
(6) pH values are not averaged and are required to be in this range.
(7) Daily average limit; calculated as the sum of nitrate + nitrite + Total Kjeldahl Nitrogen concentrations.
(8) This parameter is not a limit under the Users Agreement; however, the Town of Niskayuna sanitary code prohibits fats, waxes, grease or oils in excess of 100 mg/l.
(9) This maximum occurred in November 2013; the average for that month was 148.7 mg/l. The excess was due to a non-conforming disposal practice by subcontracted kitchen staff. The situation has been addressed and corrected.

## TABLE 4-2 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 2013

| Parameter (Units) | Number of Samples | Value[1] Minimum | Maximum | Average | Permit Limit[2] | Percent of Limit [3] |
|---|---|---|---|---|---|---|
| **Discharge Permit Requirements (Reference 3)** | | | | | | |
| **Intake Point 001** | | | | | | |
| Flow (MGD) | 53 | 2.5 | 3.6 | 3.2 | Monitor | - - |
| pH (SU) | 53 | 7.3 | 8.3 | - - | Monitor | - - |
| Total Suspended Solids (mg/l) | 53 | 1.0 | 55 | 12 | Monitor | - - |
| Total Copper (mg/l) | 28 | <0.003 | 0.008 | <0.005 | Monitor | - - |
| **Discharge Point 002** | | | | | | |
| Flow (MGD) | Continuous[4] | 0.1 | 4.6 | 2.3 | Monitor | - - |
| pH (SU) | 53 | 7.3 | 8.1 | - - | 6.5-8.5[5] | - - |
| Temperature (°F) | Continuous[4] | 29 | 81 | 53 | 90 | - - |
| Total Suspended Solids (mg/l) | 53 | <1.0 | 68 | <8.5 | Monitor | - - |
| Oil & Grease (mg/l) | 53 | <1.0 | <1.0 | <1.0 | 15 | <7 |
| Total Copper (mg/l) | 28 | <0.003 | 0.013 | <0.008 | Monitor | - - |
| Copper, Net (lbs/day) | 28 | 0.06 | 0.20 | 0.12 | Monitor | - - |
| **Discharge Point 03A** | | | | | | |
| Flow (MGD) | 16 | 0.002 | 0.022 | 0.007 | Monitor | - - |
| pH (SU) | 4 | 7.3 | 7.6 | -- | 6.5-8.5 | - - |
| Oil & Grease (mg/l) | 4 | <1.0 | <1.0 | <1.0 | 15 | <7 |
| Total Suspended Solids (mg/l) | 4 | 1.0 | 4.5 | 2.8 | Monitor | - - |
| **Discharge Point 03B** | | | | | | |
| Flow (MGD) | Continuous[4] | 0.004 | 3.8 | 2.0 | Monitor | - - |
| pH (SU) | 12 | 7.4 | 8.0 | - - | 6.5-8.5[5] | - - |
| Temperature (°F) | Continuous[4] | 31 | 85 | 54 | 90 | - - |
| Oil & Grease (mg/l) | 12 | <1.0 | <1.0 | <1.0 | 15 | <7 |
| Total Suspended Solids, Net (mg/l) | 12 | 0 | 10 | 1.1 | 50 | 20 |
| Total Copper (mg/l) | 28 | <0.003 | 0.009 | <0.006 | Monitor | - - |
| Copper, Net (lbs/day) | 28 | 0 | 0.10 | 0.02 | Monitor | - - |
| **Discharge Point 03D** | | | | | | |
| Flow (MGD) | Continuous[4] | 0.005 | 1.0 | 0.190 | Monitor | - - |
| pH (SU) | 12 | 7.3 | 8.0 | -- | 6.5-8.5[5] | - - |
| Temperature (°F) | Continuous[6] | 32 | 68 | 54 | 90 | - - |
| Oil & Grease (mg/l) | 12 | <1.0 | <1.0 | <1.0 | 15 | <7 |
| Total Suspended Solids (mg/l) | 12 | <1.0 | 152 | <17 | Monitor | - - |
| Total Copper (mg/l) | 28 | <0.003 | 0.010 | <0.004 | Monitor | - - |
| Copper, Net (lbs/day) | 28 | 0 | 0.027 | 0.002 | Monitor | - - |

Notes:

(1) A value preceded by "<" is less than the practical quantitation limit. Average values preceded by "<" contain at least one value in the average that is less than the practical quantitation limit.
(2) NYSDEC SPDES Permit (Reference (3)).
(3) Percent of limit for the maximum value, unless otherwise noted.
(4) The number of continuous monitoring days may differ slightly due to shutdown during maintenance activities.
(5) If intake pH (Outfall 001) is greater than or equal to 8.2, the upper pH limit is increased to 9.0 but in no case can the effluent pH exceed intake pH by more than 0.5 SU.
(6) Continuous temperature monitoring for Outfall 03D was performed for only 5 months during 2013 due to equipment problems. However, only monthly grab samples are required by the SPDES permit, and these were obtained monthly for the whole year.

## TABLE 4-2 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 2013 (Continued)

| Parameter (Units) | Number of Samples | Value[1] Minimum | Maximum | Average | Permit Limit [2] | Percent of Limit [3] |
|---|---|---|---|---|---|---|
| **Discharge Permit Requirements (Reference 3)** | | | | | | |
| **Discharge Point 03E** | | | | | | |
| Flow (MGD) | 12 | 0.00004 | 0.004 | 0.0007 | Monitor | - - |
| pH (SU) | 4 | 7.3 | 7.6 | - - | 6.5-8.5 | - - |
| Oil & Grease (mg/l) | 4 | <1.0 | 1.0 | <1.0 | 15 | 7 |
| Total Suspended Solids (mg/l) | 4 | <1.0 | 50 | <21 | Monitor | - - |
| **Discharge Point 001, 002, 03B and 03D** | | | | | | |
| Spectrus CT-1300 (mg/l)[4] | 0 | - - | - - | - - | 0.05 | - - |
| Copper, Net Loading (lbs/day) | 28 | 0.06 | 0.25 | 0.14 | 1.1 | 23 |
| **Discharge Point 03S** | | | | | | |
| Flow (MGD) | 53 | 0.36 | 0.50 | 0.45 | Monitor | - - |
| Total Suspended Solids (mg/l) | 24 | <1.0 | 70 | <17 | Monitor | - - |
| **Discharge Point 03T** | | | | | | |
| Flow (MGD) | 53 | 0.36 | 0.50 | 0.45 | Monitor | - - |
| Total Suspended Solids (mg/l) | 24 | <1.0 | 46 | <7.6 | Monitor | - - |
| Suspended Solids (% removal) | 24 | 0 | 86 | 56 | Monitor | - - |

Notes:

(1) A value preceded by "<" is less than the practical quantitation limit. Average values preceded by "<" contain at least one value in the average that is less than the practical quantitation limit.
(2) NYSDEC SPDES Permit (Reference (3)).
(3) Percent of limit for the maximum value, unless otherwise noted.
(4) Zebra mussel treatment using Spectrus CT-1300 was not performed in 2013.

## TABLE 4-3 CHEMICAL CONSTITUENTS IN MOHAWK RIVER WATER, 2013

| | Number of Samples | Value(1) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mohawk River Upstream (Outfall 001) | | | Mohawk River Downstream | | | |
| Parameter (Units) | Upstream/ Downstream | Minimum | Maximum | Average | Minimum | Maximum | Average | Standard(2) |
| pH (SU)(3) | 53/0 | 7.3 | 8.3 | - - | - - | - - | - - | 6.5-8.5 |
| Total Suspended Solids (mg/l) ( | 53/0 | 1.0 | 55 | 12 | - - | - - | - - | Monitor |
| Copper (mg/l)(3) | 28/0 | <0.003 | 0.008 | <0.005 | - - | - - | - - | 0.2 |
| Chloride (mg/l)(4) | 4/4 | 20 | 57 | 33 | 20 | 77 | 41 | 250 |

Notes:

(1) A value preceded by “<” is less than the practical quantitation limit for the chemical analysis. Average values preceded by “<” contain at least one value in the average that is less than the practical quantitation limit.

(2) New York State Quality Standards (Reference (1)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(3) Upstream location is a NYSDEC SPDES Permit (Reference (3)) monitoring location for this parameter (Outfall 001). However, there are no discharge limits associated with this location.

(4) Voluntary parameter.

## TABLE 4-4 CHEMICAL CONSTITUENTS IN WEST BOUNDARY STREAM DITCH AND MIDLINE STREAM, 2013

| Parameter (Units) | Number of Samples WBSD/ Midline Stream | Value[1] West Boundary Stream Ditch (WBSD) Outfall 004 | | | Midline Stream Outfall 005 | | | Standard[2] |
|---|---|---|---|---|---|---|---|---|
| | | Minimum | Maximum | Average | Minimum | Maximum | Average | |
| Flow (Estimated) GPD[3] | 4/4 | 1,500 | 160,000 | 83,000 | 61,000 | 90,000 | 35,000 | Monitor[4] |
| pH (SU) | 4/4 | 7.3 | 7.8 | - - | 7.8 | 8.1 | - - | 6.5-8.5[4] |
| Total Suspended Solids (mg/l) | 4/4 | <1.0 | 5.0 | <2.0 | <1.0 | 36 | 12 | Monitor[4] |
| Oil & Grease (mg/l) | 4/4 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 15[4] |
| Chemical Oxygen Demand (mg/l) | 4/4 | 9 | 18 | 15 | <5 | 22 | 15 | Monitor[4] |
| Chloride (mg/l)[5] | 4/4 | 418 | 2,230 | 976 | 580 | 1,140 | 865 | 250 |
| Volatile Organic Compounds (µg/l)[5][6] | 4/4 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | [7] |

Notes:

(1) A value preceded by "<" is less than the practical quantitation limit. Average values preceded by "<" contain at least one value in the average that is less than the practical quantitation limit.

(2) New York State Quality Standards (Reference (1)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. The West Boundary and Midline Streams are tributaries to the Mohawk River, which is a Class A water.

(3) Flow is estimated by measuring stream depth, width, and velocity. Flow is intermittent and is measured only when samples are collected.

(4) Permit limits as required by NYSDEC SPDES permit (Reference (3)).

(5) Voluntary parameter.

(6) EPA method 601 was utilized to analyze for volatile organic compounds listed in Table 4-16. All results were less than the practical quantitation limit of 1 µg/l.

(7) Water quality standards differ depending upon the specific parameter. The standards range from 0.07 to 50 µg/l.

# TABLE 4-5 CHEMICAL CONSTITUENTS AND TEMPERATURE IN EAST BOUNDARY STREAM, 2013

| Parameter (Units) | Number of Samples Upstream/ Downstream | East Boundary Stream Upstream[2] Minimum | East Boundary Stream Upstream[2] Maximum | East Boundary Stream Upstream[2] Average | East Boundary Stream Downstream[2] / Outfall 006 Minimum | East Boundary Stream Downstream[2] / Outfall 006 Maximum | East Boundary Stream Downstream[2] / Outfall 006 Average | Standard [3] |
|---|---|---|---|---|---|---|---|---|
| | | Value[1] | | | | | | |
| Flow (Estimated) GPD[4] | 2/6 | 4,200 | 27,000 | 16,000 | 1,700 | 1,140,000 | 360,000 | Monitor[5] |
| pH (SU) | 2/6 | 7.7 | 8.5 | -- | 7.7 | 8.5 | - - | 6.5-8.5[5] |
| Temperature (°F) | 2/2 | 42 | 51 | 46 | 45 | 51 | 48 | No Standard |
| Dissolved Oxygen (mg/l) | 2/2 | 8.5 | 9.6 | 9.0 | 6.3 | 8.4 | 7.3 | [6] |
| Specific Conductance (µmhos/cm) | 2/2 | 2,641 | 3,538 | 3,090 | 1,916 | 2,484 | 2,200 | No Standard |
| Volatile Organic Compound (µg/l)[7] | 2/2 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | [8] |
| Oil & Grease (mg/l) | 0/4 | - - | - - | - - | <1.0 | <1.0 | <1.0 | 15[5] |
| Total Suspended Solids (mg/l) | 0/4 | - - | - - | - - | <1.0 | 49 | <16 | Monitor[5] |
| Chemical Oxygen Demand (mg/l) | 0/4 | - - | - - | - - | <5 | 26 | <16 | Monitor[5] |
| Chloride (mg/l)[9] | **2/2** | 594 | 622 | 608 | 347 | 375 | 361 | 250 |

Notes:

(1) A value preceded by "<" is less than the practical quantitation limit. Average values preceded by "<" contain at least one value in the average that is less than the practical quantitation limit.
(2) Upstream samples are taken upgradient from the closed Knolls Laboratory landfill during landfill sampling events in the 2nd and 4th quarters. Downstream samples are taken downgradient from this landfill on a quarterly basis.
(3) New York State Quality Standards (Reference (1)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. The East Boundary Stream is tributary to the Mohawk River, which is a Class A water.
(4) Flow is intermittent and is estimated by measuring stream depth, width, and velocity or by volume collected over a time period. Flow is measured only when samples are collected.
(5) Permit limit as required by NYSDEC SPDES permit (Reference (3)) for the downstream location.
(6) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.
(7) EPA method 601 was used to analyze for volatile organic compounds listed in Table 4-16 . All results were less than the practical quantitation limit of 1 µg/l.
(8) Water quality standards differ depending upon the specific parameter. The standards range between 0.07 and 50 µg/l.
(9) Voluntary parameter.

## TABLE 4-6 KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT QUARTERLY COMPOSITE SAMPLE RADIOACTIVITY RESULTS, 2013

| Radionuclide | Quarterly Composite Sample Average Radioactivity Concentration(1) (pCi/liter) | | | | DOE Order 5400.5 Derived Concentration Guide (DCG) (pCi/liter) | Percent of DCG |
|---|---|---|---|---|---|---|
| Cs-137 | < | 0.47 | ± | 0.11 | 3000 | < 0.02 |
| Sr-90 | | 0.23 | ± | 0.19 | 1000 | 0.02 |
| Co-60 | < | 0.47 | ± | 0.12 | 5000 | < 0.01 |
| H-3 | < | 94.64 | ± | 3.96 | 2000000 | < 0.01 |
| Total Uranium | | 0.44 | ± | 0.03 | 500(2) | 0.09 |
| | | | | | **Total Percentage(3)** | < 0.14 |

Notes:
(1) Average values preceded by "<" contain at least one less than decision level concentration value in the average. The (±) value provides the 95% confidence interval for the average value.
(2) The derived concentration guide for total uranium is based on U-234.
(3) The radioactivity standard for the Town of Niskayuna Sanitary Sewer System corresponds to one percent of the derived concentration guide in DOE Order 5400.5 for the mixture of radionuclides present (Reference (2)).

**Radiological:** The average radioactivity concentrations in the sanitary sewage effluent to the Town of Niskayuna are shown in Table 4-6. Only strontium-90 and naturally occurring uranium were detected in the effluent composite samples. The concentration of strontium-90 is at levels typically found in surface water from historical atmospheric weapons testing. No radionuclides directly attributable to Knolls Site operations were detected in the effluent composite samples. The radioactivity concentrations in the sanitary sewage effluent were less than one percent of the DOE derived concentration guide (DCG) for effluent released to unrestricted areas (Reference (4)) as required by the Users Agreement (Reference (2)).

The radioactivity concentrations in Knolls Site liquid effluent are shown in Table 4-7. The average concentrations are all well below the DOE DCG. The amount of each radionuclide released from the Knolls Site in liquid effluent is shown in Table 4-8.

The total radioactivity released from each outfall/source is as follows: Outfall 002, 299.2 µCi; Outfall 03A, 90.9 µCi; Outfall 03D, 56.6 µCi; Outfall 03E, 0.2 µCi; Outfall 004, 109.3 µCi and Lower Level Parking Lot/River Bank Seepage, 1.2 µCi for a total of 557.4 µCi (or $5.57 \times 10^{-4}$ Ci). The radioactivity was contained in approximately $3.49 \times 10^{9}$ liters of water released from the Knolls Site. The annual average radioactivity concentration in that effluent, prior to entering the Mohawk River water, corresponded to less than 0.1 percent of the DOE DCG for effluent released to unrestricted areas (Reference (4)) for the mixture of radionuclides present.

# TABLE 4-7 RADIOACTIVITY CONCENTRATIONS IN KNOLLS SITE LIQUID EFFLUENT, 2013

| Sample Point/ Parameter | Number of Samples | Radioactivity Concentration (pCi/l)(1) Minimum | Maximum | Average | DOE Order 5400.5 DCG(2) | Percent of DCG |
|---|---|---|---|---|---|---|
| **Outfall 002** | | | | | | |
| Gross Alpha | 12 | < 0.93 | 2.73 ± 2.98 | < 1.40 ± 0.40 | 30 | < 4.68 |
| Gross Beta | 12 | < 0.94 | 11.26 ± 2.16 | < 3.57 ± 1.77 | 1000 | < 0.36 |
| Sr-90 | 12 | < 0.08 | 0.41 ± 0.14 | < 0.15 ± 0.06 | 1000 | < 0.02 |
| Cs-137 | 12 | < 0.11 | < 0.17 | < 0.14 ± 0.02 | 3000 | < 0.01 |
| H-3 | 12 | < 90.1 | < 101.0 | < 94.9 ± 2.2 | 2,000,000 | < 0.01 |
| **Outfall 03A** | | | | | | |
| Gross Alpha | 12 | < 2.29 | < 12.40 | < 9.06 ± 1.83 | 30 | < 30.20 |
| Gross Beta | 12 | 5.21 ± 2.63 | 32.37 ± 10.83 | 19.87 ± 5.38 | 1000 | 1.99 |
| Sr-90 | 12 | 1.12 ± 0.21 | 10.47 ± 0.64 | 5.82 ± 1.57 | 1000 | 0.58 |
| Cs-137(3) | 4 | < 0.12 | < 0.17 | < 0.14 ± 0.05 | 3000 | < 0.01 |
| **Outfall 03B** | | | | | | |
| Gross Alpha(3) | 4 | < 0.81 | 1.40 ± 1.45 | < 1.14 ± 0.44 | 30 | < 3.81 |
| Gross Beta(3) | 4 | 1.39 ± 1.01 | 4.83 ± 1.47 | 2.71 ± 2.57 | 1000 | 0.27 |
| **Outfall 03D** | | | | | | |
| Gross Alpha | 12 | < 0.82 | < 7.06 | < 4.25 ± 1.60 | 30 | < 14.17 |
| Gross Beta | 12 | < 0.91 | 20.73 ± 3.56 | < 8.16 ± 4.26 | 1000 | < 0.82 |
| Sr-90 | 12 | < 0.09 | 1.82 ± 0.30 | < 0.90 ± 0.47 | 1000 | < 0.09 |
| Cs-137(3) | 4 | < 0.12 | < 0.17 | < 0.13 ± 0.04 | 3000 | < 0.01 |
| **Outfall 03E** | | | | | | |
| Gross Alpha(4) | 9 | 1.90 ± 1.85 | 22.76 ± 10.60 | < 8.80 ± 5.71 | 30 | < 29.32 |
| Gross Beta(4) | 9 | 2.83 ± 3.20 | 24.05 ± 10.81 | < 8.62 ± 5.64 | 1000 | < 0.86 |
| Sr-90(4) | 9 | < 0.10 | 0.48 ± 0.15 | < 0.22 ± 0.12 | 1000 | < 0.02 |
| Cs-137(3)(4) | 4 | < 0.12 | < 0.49 | < 0.24 ± 0.26 | 3000 | < 0.01 |
| **Outfall 004** | | | | | | |
| Gross Alpha(4) | 12 | < 2.15 | < 13.71 | < 7.38 ± 2.03 | 30 | < 24.61 |
| Gross Beta(4) | 12 | 3.05 ± 1.90 | 34.61 ± 11.98 | < 10.72 ± 5.59 | 1000 | < 1.07 |
| Sr-90(4) | 12 | 0.96 ± 0.20 | 2.32 ± 0.15 | 1.48 ± 0.26 | 1000 | 0.15 |
| Cs-137(4) | 12 | < 0.06 | 0.77 ± 0.13 | < 0.20 ± 0.12 | 3000 | < 0.01 |
| **Outfall 005** | | | | | | |
| Gross Alpha(3)(4) | 4 | < 3.76 | < 8.51 | < 5.83 ± 3.45 | 30 | < 19.42 |
| Gross Beta(3)(4) | 4 | 3.70 ± 3.37 | 19.23 ± 8.51 | < 8.24 ± 11.72 | 1000 | < 0.82 |
| Sr-90(3)(4) | 4 | 0.14 ± 0.13 | 0.26 ± 0.14 | 0.21 ± 0.08 | 1000 | 0.02 |
| Cs-137(3)(4) | 4 | < 0.12 | < 0.16 | < 0.14 ± 0.04 | 3000 | < 0.01 |
| **Outfall 006** | | | | | | |
| Gross Alpha(3)(4) | 4 | < 0.66 | < 6.29 | < 3.47 ± 3.83 | 30 | < 11.56 |
| Gross Beta(3)(4) | 4 | 2.55 ± 2.40 | 5.59 ± 5.35 | < 4.28 ± 2.19 | 1000 | < 0.43 |
| Sr-90(3)(4) | 4 | 0.13 ± 0.12 | 0.32 ± 0.16 | 0.23 ± 0.13 | 1000 | 0.02 |
| Cs-137(3)(4) | 4 | < 0.11 | < 0.17 | < 0.14 ± 0.05 | 3000 | < 0.01 |

Notes:
(1) A value preceded by "<" is less than the decision level concentration. Average values preceded by "<" contain at least one value that is less than the decision level concentration. The (±) value provides the 95% confidence interval for the value.
(2) The derived concentration guide (DCG) for gross alpha and gross beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of Knolls Site operations.
(3) Monthly samples are composited and analyzed quarterly.
(4) Samples may not be obtained every month due to dry or frozen conditions.

## TABLE 4-7 RADIOACTIVITY CONCENTRATIONS IN KNOLLS SITE LIQUID EFFLUENT, 2013 (Continued)

| Sample Point/ Parameter | Number of Samples | Radioactivity Concentration (pCi/l)[1] Minimum | Maximum | Average | DOE Order 5400.5 DCG[2] | Percent of DCG |
|---|---|---|---|---|---|---|
| **Seepage from Parking Lot** | | | | | | |
| Gross Alpha[4] | 3 | < 6.32 | < 12.29 | < 9.13 ± 7.45 | 30 | < 30.42 |
| Gross Beta[4] | 3 | < 4.34 | < 6.85 | < 5.81 ± 3.26 | 1000 | < 0.58 |
| Sr-90[4] | 3 | 0.32 ± 0.17 | 1.46 ± 0.26 | 1.01 ± 1.50 | 1000 | 0.10 |
| Cs-137[3][4] | 2 | < 0.12 | < 0.36 | < 0.24 ± 1.49 | 3000 | < 0.01 |
| **River Bank Seepage** | | | | | | |
| Gross Alpha | 2 | < 8.06 | 9.59 ± 13.72 | < 8.83 ± 9.71 | 30 | < 29.42 |
| Gross Beta | 2 | 3.37 ± 4.27 | < 6.70 | < 5.04 ± 21.11 | 1000 | < 0.50 |
| Sr-90 | 2 | 0.85 ± 0.21 | 1.06 ± 0.22 | 0.95 ± 1.32 | 1000 | 0.10 |
| Cs-137 | 2 | < 0.37 | < 0.38 | < 0.37 ± 0.05 | 3000 | < 0.01 |
| **West Landfill Stream** | | | | | | |
| Gross Alpha[3][4] | 4 | < 0.72 | 2.69 ± 2.19 | < 1.28 ± 1.51 | 30 | < 4.25 |
| Gross Beta[3][4] | 4 | 1.59 ± 1.09 | 8.36 ± 1.71 | 3.37 ± 5.30 | 1000 | 0.34 |
| **Upper East Boundary Stream** | | | | | | |
| Gross Alpha[3][4] | 4 | < 3.56 | < 10.90 | < 5.84 ± 5.41 | 30 | < 19.47 |
| Gross Beta[3][4] | 4 | < 3.07 | 9.55 ± 8.16 | < 5.28 ± 4.77 | 1000 | < 0.53 |
| Sr-90[3][4] | 4 | < 0.10 | 0.33 ± 0.13 | < 0.22 ± 0.15 | 1000 | < 0.02 |
| Cs-137[3][4] | 4 | < 0.13 | < 0.17 | < 0.16 ± 0.03 | 3000 | < 0.01 |
| **Upper West Boundary Stream (background for comparison)** | | | | | | |
| Gross Alpha[4] | 12 | < 0.98 | < 2.10 | < 1.61 ± 0.26 | 30 | < 5.37 |
| Gross Beta[4] | 12 | < 1.66 | 5.95 ± 1.63 | < 3.30 ± 1.00 | 1000 | < 0.33 |
| Sr-90[4] | 12 | < 0.09 | 0.22 ± 0.14 | < 0.13 ± 0.03 | 1000 | < 0.01 |
| Cs-137[4] | 12 | < 0.13 | < 0.17 | < 0.16 ± 0.01 | 3000 | < 0.01 |
| H-3[4] | 12 | < 90.6 | < 100.2 | < 95.2 ± 1.9 | 2,000,000 | < 0.01 |
| **Site Service Water (background for comparison)** | | | | | | |
| Gross Alpha | 12 | < 0.37 | < 1.62 | < 1.13 ± 0.21 | 30 | < 3.76 |
| Gross Beta | 12 | < 0.86 | 5.16 ± 1.85 | < 2.26 ± 0.77 | 1000 | < 0.23 |
| Sr-90 | 12 | < 0.08 | 0.20 ± 0.12 | < 0.11 ± 0.02 | 1000 | < 0.01 |
| Cs-137 | 12 | < 0.12 | < 0.17 | < 0.16 ± 0.01 | 3000 | < 0.01 |
| H-3 | 12 | < 90.3 | < 99.5 | < 94.7 ± 2.0 | 2,000,000 | < 0.01 |
| **Mohawk River Cooling Water (background for comparison)** | | | | | | |
| Gross Alpha | 12 | < 0.58 | 14.46 ± 6.73 | < 2.19 ± 2.47 | 30 | < 7.30 |
| Gross Beta | 12 | < 0.92 | 22.30 ± 3.46 | < 4.14 ± 3.73 | 1000 | < 0.41 |
| Sr-90 | 12 | < 0.08 | 0.22 ± 0.12 | < 0.11 ± 0.03 | 1000 | < 0.01 |
| Cs-137 | 12 | < 0.12 | < 0.17 | < 0.13 ± 0.01 | 3000 | < 0.01 |
| H-3 | 12 | < 90.6 | < 100.0 | < 95.0 ± 2.1 | 2,000,000 | < 0.01 |

Notes:
(1) A value preceded by "<" is less than the decision level concentration. Average values preceded by "<" contain at least one value that is less than the decision level concentration. The (±) value provides the 95% confidence interval for the value.
(2) The derived concentration guide (DCG) for gross alpha and gross beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of Knolls Site operations.
(3) Monthly samples are composited and analyzed quarterly.
(4) Samples may not be obtained every month due to dry or frozen conditions.

**TABLE 4-8 KNOLLS SITE RADIOACTIVITY RELEASED IN LIQUID EFFLUENT, 2013**

| Radionuclide | Release Ci(1) | Half-life |
|---|---|---|
| Sr-90 | 2.76E-04 | 28.78 years |
| Y-90 | 2.76E-04 | 2.67 days |
| Cs-137 | 6.05E-06 | 30.07 years |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | 2.82E-04 | |

Note: (1) The totals include results that were less than or equal to the decision level concentration.

## 4.3 AIRBORNE EFFLUENT MONITORING

### 4.3.1 Sources

**Nonradiological:** The principal source of industrial air emissions is the Knolls Laboratory steam-generating heating boiler system. The Knolls Laboratory heating boilers are comprised of three stationary combustion units that burn natural gas with low sulfur distillate fuel oil used as a backup fuel. The combustion products from this source are released through individual elevated stacks. Another stationary combustion source is the Advanced Steam Generator Test Facility (ASGTF) that is comprised of two natural gas-fired water heaters that exhaust through a common stack.

In June 2006, one of the ASGTF natural gas fired water heater units was removed from long term lay-up and test fired. This unit was used to generate steam for a test platform starting in 2008 and ending in 2010. This unit did not operate during 2013 and was put in long term lay-up.

Other operations at the Knolls Laboratory that can result in air emissions include a vacuum induction melting/gas atomization (VIMGA) unit (currently in long term layup), a carpenter shop, metal work operations, belt grinders, welding, non-radiological laboratory hoods, and emergency power diesel generators. These sources of air emissions at the Knolls Laboratory meet the criteria for exempt and trivial sources under the NYSDEC air regulations and are not required to have air permits or registrations.

**Radiological:** Laboratory operations capable of generating airborne radioactivity are serviced by controlled exhaust systems that discharge through stacks. To minimize radioactivity content, the exhaust air is passed through appropriate air cleaning devices, such as high efficiency particulate air (HEPA) filters or HEPA filters and activated carbon adsorbers, prior to release. Potential diffuse sources are also evaluated and may include emissions from resuspension of contaminated soil, D&D activities, and fugitive building emissions.

### 4.3.2 Effluent Monitoring

**Nonradiological:** The Knolls Laboratory originally had two nonradiological air emission permits, one for the Site heating boilers and one for the ASGTF. Effective December 7, 2009, the permits for these two air emission sources were consolidated under the Air State Facility Permit (Mod 2). This new permit limits carbon monoxide and sulfur dioxide emissions from the Site heating boilers based on fuel usage. The New York State emission standards for stationary combustion installations are listed in Reference (5). Under the terms of the permit for these emission sources, direct emission monitoring is not required. The quantities of pollutants released are estimated based on the quantity and type of fuel burned multiplied by the appropriate EPA approved emission factors. In January 2010, the Knolls

Laboratory was granted a modification to the Air State Facility Permit (Mod 4), listed in Table 3-1, to consolidate the reporting dates for certain regulatory submittals listed in the permit.

The NYSDEC regulations do not require air emission permits for exempt and trivial activities. Under these regulations the air permit for the VIMGA unit was canceled in 2001 by NYSDEC since it is a research and development unit with insignificant regulated pollutant emissions and was exempt from permitting requirements. In general, exempt and trivial activities do not require emissions monitoring; although some activities may require monitoring of run times, installation and maintenance of air quality control equipment, or limiting source material usage to maintain their exempt status.

**Radiological:** Airborne effluents from the main radiological emission points are continuously sampled for particulate radioactivity with particulate filter samplers and with activated charcoal cartridge samplers where iodine or antimony may be present. Exhaust systems servicing major facilities are also continuously monitored for particulate, iodine, and noble gas radioactivity. The monitors continuously record radioactivity levels in the effluents and are equipped with alarm functions to provide an alert should an abnormal level occur. Other minor radiological emission points are evaluated for the potential for release and monitored on a periodic basis, as necessary, to confirm the low emissions.

### 4.3.3 Effluent Analyses

**Radiological:** Particulate filters and activated charcoal cartridges are changed and analyzed on a routine basis. Particulate filters are analyzed by direct counting for gross alpha and beta radioactivity using a sensitive low-background gas proportional counting system. The system provides decision level concentrations for alpha and beta radioactivity of approximately $1 \times 10^{-15}$ μCi/ml and $5 \times 10^{-15}$ μCi/ml, respectively. The activated charcoal cartridges are analyzed for iodine and antimony-125 by gamma spectrometry, which provides decision level concentrations of approximately $2 \times 10^{-14}$ μCi/ml and $1 \times 10^{-13}$ μCi/ml, respectively. Noble gas radioactivity released is calculated based on integration of recorded data from a continuous noble gas monitor.

### 4.3.4 Assessment

**Nonradiological:** The Knolls Laboratory switched from daily fuel usage monitoring to a monthly fuel usage monitoring program for its permitted combustion operations in accordance with regulations promulgated during 2008. With the change in monitoring frequency, the applicability of the hourly emission limits listed in the heating boilers' original air emission permit was reviewed with NYSDEC. With concurrence from NYSDEC, the requirements to comply with the hourly emissions limits listed in the permit were canceled. The heating boiler operations at the Knolls Laboratory are "capped," or limited, to the following conditions under the Air State Facility Permit (Mod 4) issued by NYSDEC:

1. A maximum heat input of 162.4 billion BTUs during any 12-month period;

2. The quantity of fuel used during any 12-month period shall not exceed 159.2 million standard cubic feet (SCF) of natural gas or 1.16 million gallons of distillate fuel oil or any combination of the two, not to exceed condition 1 above;

3. Annual emissions of the following contaminants are capped as follows:
   Carbon monoxide (CO) – 13,370 pounds per year
   Sulfur dioxide ($SO_2$) – 82,360 pounds per year;

4. The sulfur content of any fuel oil burned shall not exceed 0.5 percent by weight, and the fuel oil must conform to the specifications for distillate fuel oil per ASTM D396-78, as amended; and

5. The annual capping period will now run from the first working day in September to the first working day in September of the following year with the Annual Capping Certification due by September 30 each year.

The ASGTF hot water heater operations are not capped by the Air State Facility Permit (Mod 4).

Fuel oil supplier certification statements and applicable fuel oil analyses for distillate fuel oil are maintained to confirm that the fuel oil burned in the Knolls Laboratory heating boilers contained less than 0.5 percent sulfur by weight and conforms to the ASTM Standards for distillate fuel oil. Semiannual reports demonstrating compliance with the fuel oil sulfur limitation are sent to both the EPA and NYSDEC.

Compliance with the capping requirements is determined by calculations using fuel usage records each year and an annual capping certification statement is sent to NYSDEC. Although the emissions from the operation of Air Emission Point EP-00030, ASTGF, are not capped; the emissions from this facility are included in the capping certification for information.

The Knolls Laboratory heating boilers continue to operate within the capped operating and emission limits established by NYSDEC in the Knolls Laboratory's operating permit for the boilers.

In May 2011, the Knolls Laboratory opted to operate the Site heating boilers as gas-fired boilers under 40 CFR 63 Subpart JJJJJJ - National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers located at Area Sources of Hazardous Air Pollutants. For gas-fired boilers, the combustion of fuel oil is limited to periods of gas curtailment, gas supply emergencies, or periodic testing on fuel oil (i.e., boiler tune ups). Periodic testing of fuel oil, under this regulation, is limited to 48 hours of combustion per boiler during any calendar year.

**Radiological:** The radioactivity released in airborne effluent during 2013 is shown in Table 4-9. The point source airborne radioactivity was contained in a total air exhaust volume of 1.52 x $10^{12}$ liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (4). The diffuse source emissions are calculated using EPA approved methods and represent a small fraction of the point source emissions. The radioactivity concentration for the year at the nearest Knolls Laboratory boundary, based on the annual diffusion parameters, averaged less than 0.01 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference (4)) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required by EPA regulations in Reference (6).

## TABLE 4-9 KNOLLS LABORATORY RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT, 2013

| Radionuclide | Point Source Release Ci[1] | Diffuse Source Release Ci | Total Release Ci | Half-life |
|---|---|---|---|---|
| H-3 | 1.25E-07 | 0.00E-00 | 1.25E-07 | 12.32 years |
| Kr-85 | 7.45E-02 | 0.00E-00 | 7.45E-02 | 10.76 years |
| Sr-90 | 2.60E-06 | 4.45E-08 | 2.65E-08 | 28.78 years |
| Y-90 | 2.60E-06 | 4.45E-08 | 2.65E-06 | 2.67 days |
| Cs-137 | 2.60E-06 | 2.26E-07 | 2.83E-06 | 30.07 years |
| Co-60 | 1.50E-08 | 4.17E-12 | 1.50E-08 | 5.271 years |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | 5.22E-06 | 2.71E-07 | 5.49E-06 | |
| U-234 | 5.61E-07 | 1.67E-09 | 5.62E-07 | 2.46E05 years |
| U-235 | 9.41E-09 | 4.66E-11 | 9.46E-09 | 7.04E08 years |
| U-236 | 1.75E-09 | 5.31E-12 | 1.75E-09 | 2.34E07 years |
| U-238 | 1.08E-11 | 3.52E-13 | 1.11E-11 | 4.47E09 years |
| Total Uranium | 5.72E-07 | 1.72E-09 | 5.73E-07 | |
| Pu-238 | 2.60E-07 | 7.35E-12 | 2.60E-07 | 87.7 years |
| Pu-239 | 0.00E-00 | 2.93E-10 | 2.93E-10 | 2.41E04 years |
| Pu-240 | 0.00E-00 | 7.55E-11 | 7.55E-11 | 6.56E03 years |
| Pu-242 | 0.00E-00 | 7.22E-15 | 7.22E-15 | 3.75E05 years |
| Total Plutonium (Alpha) | 2.60E-07 | 3.76E-10 | 2.60E-07 | |
| Am-241 | 0.00E-00 | 7.67E-11 | 7.67E-11 | 432.7 years |
| Pu-241 | 0.00E-00 | 1.45E-10 | 1.45E-10 | 14.29 years |

Note: (1) With the exception of Kr-85, the totals include results that were less than or equal to the decision level concentration.

## 4.4 ENVIRONMENTAL MONITORING

### 4.4.1 Scope

**Nonradiological:** The Knolls Laboratory nonradiological environmental monitoring program consists of routine surface water and groundwater sampling. Surface water is sampled for water quality at the following locations: Mohawk River upstream and downstream from the Knolls Laboratory outfalls, the Midline Stream near the point of entry to the Mohawk River, the West Boundary Stream Ditch, and the East Boundary Stream upstream and downstream of the closed landfill. The West Boundary Stream Ditch sample point is on Knolls Laboratory property, prior to where the ditch enters the West Boundary Stream on the GE Global Research Center property. The West Boundary Stream Ditch enters the Mohawk River upstream from the Knolls Laboratory. A fourth intermittent surface drainage-way, the West Landfill Stream, is also monitored when possible. Required analytical surface water parameters are discussed in Section 4.2. Stream sample points are shown on Figure 4-1.

The Knolls Laboratory contains a permanently capped landfill that covers an area of approximately 3.7 acres on the east side of the site. The landfill was officially closed in October 1993. The groundwater and surface water surrounding the closed landfill is routinely monitored and the results are reported to NYSDEC in compliance with Reference (7). Quarterly landfill inspections were conducted and no degradation in the cap was identified. Routine landfill maintenance was performed to ensure continued integrity of the landfill cap and associated cover. Groundwater is also monitored by permanent groundwater monitoring wells located throughout the Knolls Laboratory. Knolls Laboratory groundwater data are discussed separately in Section 4.6.

**Radiological:** The Knolls Laboratory radiological environmental monitoring program includes: a) the routine collection and analysis of samples of Mohawk River water, sediment, and fish; surface water streams; groundwater; and local municipal waters; and b) the continuous sampling of air at stations located in the predominant upwind and downwind directions from the Knolls Laboratory.

Mohawk River water and bottom sediment samples are collected for radioactivity analyses at locations upstream and downstream from the main Knolls Laboratory outfall as shown in Figure 4-2. Samples are collected during each of three (3) calendar quarters; ice coverage and/or winter weather prevents sampling during the first calendar quarter. A Birge-Ekman dredge, which samples an area of approximately 15 cm x 15 cm to an average depth of 2.5 cm, is used for the collection of sediment samples. In addition, bottom feeding fish and recreational sport fish are collected from the Mohawk River upstream and downstream from the main Knolls Laboratory outfall for gamma spectrometry and radiochemical analyses.

Surface water is also sampled monthly for radioactivity at the Midline Stream near the point of entry to the Mohawk River, the West Boundary Stream Ditch, and the East Boundary Stream upstream and downstream of the closed landfill, and the West Landfill Stream. Perimeter radiation levels are continuously monitored with thermoluminescent dosimeters (TLDs) and are discussed separately in Section 4.5. Groundwater wells are sampled annually for radioactivity and are discussed separately in Section 4.6.

The municipal water systems servicing the area surrounding the Knolls Laboratory are those of Schenectady, Niskayuna and Latham/Colonie, New York. Supply wells for the Schenectady and Niskayuna systems are located upstream and downstream, respectively, from the Knolls Laboratory. Although there is no direct mechanism for Knolls Laboratory effluent to enter the water supplies, samples are collected monthly from the Schenectady and Niskayuna municipal water systems. A monthly sample is also collected from the Latham/Colonie municipal water system that obtains a portion of its water from the Mohawk River. Monthly samples are composited quarterly and analyzed for radioactivity.

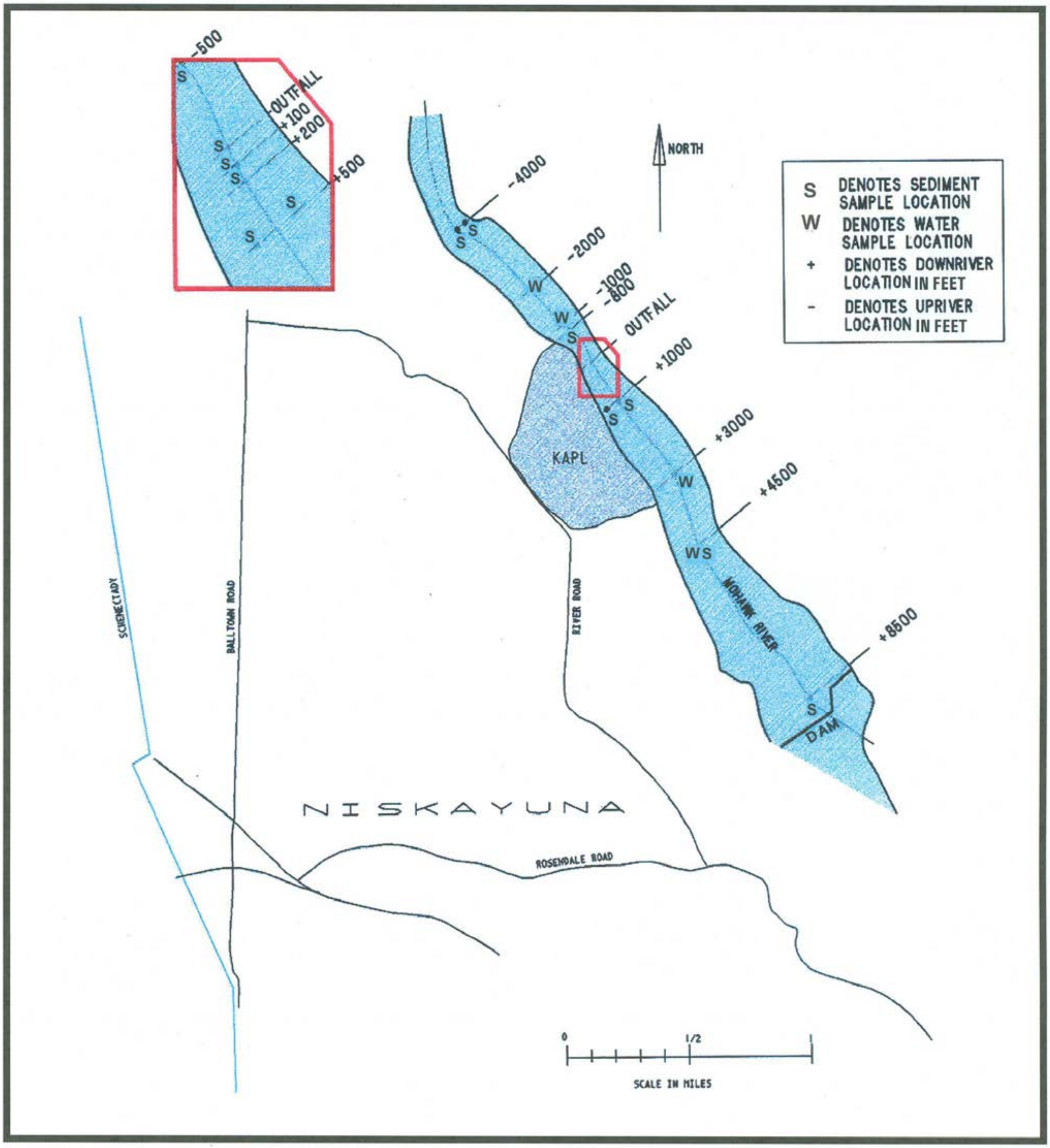



**Figure 4-2**
**Knolls Laboratory, Niskayuna, New York**
**Mohawk River Sampling Locations**

Environmental air samplers are operated in the predominant upwind and ten downwind locations around the entire perimeter of the Knolls Site to measure normal background airborne radioactivity, and to confirm that Knolls Laboratory effluents have no measurable effect on normal background airborne radioactivity levels.

### 4.4.2 Analyses

**Nonradiological:** The water samples collected from the Mohawk River and the three main surface water streams are analyzed for the constituents listed in Tables 4-3, 4-4, and 4-5. Samples are also collected from the West Landfill Stream when possible during post-closure landfill monitoring operations. West Landfill Stream samples have not been obtainable since 2000 because there has been no flow in the stream concurrent with landfill post-closure monitoring events. The analyses, when samples are available, are performed in accordance with 40 CFR Part 136 utilizing the procedures provided in Standard Methods, Reference (8), or other EPA approved methods.

**Radiological:** The individual quarterly samples of Mohawk River water and quarterly composite samples of Schenectady, Niskayuna, and Latham/Colonie municipal waters are analyzed for gross alpha and gross beta radioactivity. The stream samples are analyzed for gross alpha and gross beta radioactivity, and for other radionuclides as appropriate. The methods used are described in Section 4.2.3, Effluent Analyses.

The Mohawk River sediment samples are analyzed for uranium and plutonium alpha radioactivity by chemical extraction with subsequent direct counting on an alpha spectrometry system, for gross beta radioactivity by direct counting of a dried sample, and for cesium-137 and other gamma emitting radionuclides by gamma spectrometry. Seven samples from the second quarter sample set collected at locations upstream, opposite, and downstream from the main Knolls Laboratory outfall (i.e., Outfall 002) are also analyzed for strontium-90 by chemical extraction and gross beta counting. The downstream samples for strontium analyses are selected from locations that previous monitoring had indicated would be locations of highest concentrations. In addition, a more sensitive gamma spectrometry analyses is performed annually on some of the sediment samples. This more sensitive analysis is intended to fully characterize the low levels of both naturally and non-naturally occurring gamma emitting radionuclides in the sediment.

Edible portions of the fish collected from the Mohawk River are analyzed for gamma emitting radionuclides with a high purity germanium spectrometer system, for strontium-90 by chemical extraction and beta counting, and for plutonium by chemical separation followed by alpha spectrometry.

The environmental air sample filters are changed on a routine basis and analyzed by direct counting for gross alpha and gross beta radioactivity using the method described in section 4.3.3. An environmental air sampler was installed in May 2011 near Outfall 002 that is owned and operated by the New York State Department of Health (NYSDOH) as a result of the September 29, 2010 SPRU radiological contamination event during Building H2 demolition.

### 4.4.3 Assessment

**Nonradiological:** The results of the analyses of Mohawk River water for chemical quality are summarized in Table 4-3. Results of routine analyses in the West Boundary Stream Ditch and Midline Stream are summarized in Table 4-4, and results for the East Boundary Stream are summarized in Table 4-5. Analyzed parameters were generally below the New York State standards for Class A waters for the section of the Mohawk River that borders the Knolls Laboratory. The surface water database shows that there is no water quality degradation attributable to the Knolls Laboratory.

Voluntary surface water monitoring is also performed for other parameters at these locations to supplement the regulatory required SPDES and landfill post-closure monitoring activities. The data from samples analyzed during 2013 continued to indicate there is no adverse impact from current Knolls Laboratory operations on the Mohawk River or the closed landfill on the surrounding surface water streams. Instances where surface water standards or guidance values have been exceeded are discussed below.

Current Knolls Laboratory Operations

The Midline Stream has the potential to be influenced by runoff from the east side of the Knolls Laboratory. The West Boundary Stream ditch captures runoff from an on-site road. Therefore, the Knolls Laboratory SPDES Permit requires the stormwater for these areas to be monitored. Additional voluntary monitoring is also performed and is presented in Tables 4-3, 4-4, and 4-5. The State water quality standard for chloride was exceeded in West Boundary Stream Ditch, Midline Stream and East Boundary Stream. The high chloride results were attributed to winter road salting and snow/ice removal operations.

Surface Water Near the Closed Landfill

The former Knolls Laboratory landfill (permanently closed and capped in 1993) is bordered by the East Boundary Stream, the West Landfill Stream (which is frequently dry), and the Mohawk River to the north. Sample data for the East Boundary Stream is presented in Table 4-5. The East Boundary Stream upstream and downstream locations were sampled concurrently with landfill post-closure monitoring activities. The high chloride results in the East Boundary Stream can be attributed to winter road salting and snow/ice removal operations.

Sufficient water was not present in the West Landfill Stream to allow sampling in 2013. Results from the West Landfill Stream prior to 1999 suggested that water quality in this surface water drainage-way may be influenced by a leachate component in the closed landfill. The West Landfill Stream, which is typically dry or has little to no flow, does not directly enter the Mohawk River but rather infiltrates into a low lying area adjacent to the former rail bed that exists near the river.

The Mohawk River and East Boundary Stream data, as previously discussed, do not indicate any measurable impact from the former landfill.

**Radiological:** Results of the radioactivity analyses performed on samples of Mohawk River and municipal waters are summarized in Table 4-10. The results for the gross alpha and gross beta radioactivity concentrations show no significant difference between river water samples upstream and downstream from the Knolls Laboratory or in Schenectady, Niskayuna, and Latham/Colonie municipal waters.

The results of radioactivity measurements for gross beta, strontium-90, cesium-137, plutonium, and uranium in Mohawk River bottom sediment samples are summarized in Table 4-11. The 2013 data show no significant differences between upstream and downstream radioactivity concentrations for gross beta, strontium-90, cesium-137, plutonium, and uranium. Historically, slightly higher concentrations of radioactivity have occasionally been measured in samples collected from locations within one thousand feet downstream from the main Knolls Laboratory outfall. This localized concentration of radioactivity is attributed to operations conducted prior to 1964, when the facility was subject to applicable Federal regulations and State and local agreements through the Mohawk River Advisory Committee, that permitted limited amounts of radioactivity to be released to the Mohawk River. These low levels of radioactivity in the river sediment do not present a health risk since the radioactivity is deposited as bottom sediment, which is not subject to becoming airborne and is unlikely to interact with the aquatic environment. This is further discussed in Section 4.4.4.

The results of the detailed gamma spectrum analyses performed on Mohawk River bottom sediment samples also indicated the expected low levels of potassium-40 and daughters of uranium and thorium. The potassium-40 and daughters of uranium and thorium are naturally-occurring radionuclides. No detectable cobalt-60 was found in any of the samples. However, localized low levels of cobalt-60, attributable to operations prior to 1964, have been observed occasionally in past river sediment samples.

The analytical results for the fish collected from the Mohawk River are summarized in Table 4-12 and Table 4-13. The results indicate the presence of naturally occurring potassium-40. The results of sensitive analyses for strontium-90 and plutonium indicate little or no detectable strontium-90 or plutonium in either upstream or downstream fish. The measured concentrations of radioactivity indicate no effect from Knolls Laboratory operations. In addition, the results of a detailed biological survey (Reference (9)) confirm that the low levels of radioactivity in the Mohawk River bottom sediment near the main Knolls Laboratory outfall (Outfall 002) are not taken up and propagated through the food chain.

The analytical results for the environmental air samples for 2013 indicate that there were no significant differences between the average upwind and downwind radioactivity concentrations. The average upwind gross alpha and gross beta radioactivity concentrations were $1.1 \times 10^{-15}$ µCi/ml and $1.6 \times 10^{-14}$ µCi/ml, respectively. The average downwind gross alpha and gross beta radioactivity concentrations were $1.2 \times 10^{-15}$ µCi/ml and $1.7 \times 10^{-14}$ µCi/ml, respectively. Gamma spectrometry analyses performed on the environmental air samples indicated only background quantities of naturally occurring radionuclides. Additionally, there were no significant differences between the NYSDOH environmental air sampling results and the KAPL results.

## TABLE 4-10 RESULTS OF MONITORING MOHAWK RIVER WATER AND MUNICIPAL WATER, 2013

| Location and Source of Water Sample | Number of Samples | Radioactivity Concentrations (pCi/liter)[1,2,3] Gross Beta Values Minimum | Gross Beta Maximum | Gross Beta Average | Gross Alpha Values Minimum | Gross Alpha Maximum | Gross Alpha Average |
|---|---|---|---|---|---|---|---|
| **Mohawk River** | | | | | | | |
| Upstream | 6 | 1.88 ± 0.64 | 3.41 ± 0.85 | 2.59 ± 0.67 | 0.51 ± 0.89 | < 1.10 | < 0.71 ± 0.25 |
| Downstream | 6 | 1.80 ± 0.89 | 3.17 ± 0.84 | 2.52 ± 0.57 | 0.55 ± 0.96 | < 1.11 | < 0.83 ± 0.25 |
| Schenectady[4] | | | | | | | |
| Municipal Water | 4 | 1.06 ± 1.05 | 2.71 ± 1.27 | 1.67 ± 1.16 | < 1.08 | 1.40 ± 2.12 | < 1.23 ± 0.22 |
| Niskayuna[4] | | | | | | | |
| Municipal Water | 4 | < 0.78 | 2.58 ± 1.29 | < 1.55 ± 1.24 | < 1.27 | 2.95 ± 2.61 | < 1.73 ± 1.30 |
| Latham/Colonie[4] | | | | | | | |
| Municipal Water | 4 | < 0.78 | 3.41 ± 1.33 | < 1.82 ± 1.87 | < 0.88 | < 1.23 | < 0.99 ± 0.26 |

Notes:

(1) The (±) value for average values provides the 95% confidence interval for the average value. The lowest possible value for any parameter is zero.

(2) A value preceded by "<" is less than the decision level concentration for that sample and parameter.

(3) Average values preceded by "<" contain at least one value that is less than the decision level concentration.

(4) Monthly samples are composited and analyzed quarterly.

## TABLE 4-11 RESULTS OF ANALYSES OF MOHAWK RIVER SEDIMENT FOR RADIOACTIVITY, 2013

| Number of Samples and Type of Results | Radioactivity Concentration (pCi/gm, dry weight)(1) — Area Sampled Relative to Effluent Point: Upstream | Opposite | Downstream |
|---|---|---|---|
| **Gross Beta Concentration** | | | |
| Number of Samples | 12 | 3 | 24 |
| Average Concentration | 30.48 ± 3.03 | 28.80 ± 15.91 | 32.59 ± 2.21 |
| Minimum Concentration | 21.37 ± 5.00 | 24.79 ± 5.51 | 25.06 ± 5.54 |
| Maximum Concentration | 38.80 ± 6.63 | 36.18 ± 6.45 | 41.67 ± 6.90 |
| **Sr-90 Concentration** | | | |
| Number of Samples | 4 | 1 | 2 |
| Average Concentration | < 0.01 ± 0.01 | < 0.01 | < 0.02 ± 0.04 |
| Minimum Concentration | < 0.01 | < 0.01 | < 0.02 |
| Maximum Concentration | 0.02 ± 0.02 | < 0.01 | 0.03 ± 0.02 |
| **Cs-137 Concentration** | | | |
| Number of Samples | 12 | 3 | 24 |
| Average Concentration | < 0.04 ± 0.01 | < 0.04 ± 0.08 | < 0.04 ± 0.01 |
| Minimum Concentration | 0.01 ± 0.01 | < 0.02 | < 0.01 |
| Maximum Concentration | 0.08 ± 0.03 | 0.07 ± 0.03 | 0.10 ± 0.03 |
| **Plutonium Concentration(2)** | | | |
| Number of Samples | 12 | 3 | 24 |
| Average Concentration | < 0.01 ± 0.01 | < 0.01 ± 0.01 | < 0.01 ± 0.01 |
| Minimum Concentration | < 0.01 | < 0.01 | < 0.01 |
| Maximum Concentration | < 0.01 | 0.01 ± 0.01 | 0.01 ± 0.01 |
| **Uranium Concentration(3)** | | | |
| Number of Samples | 12 | 3 | 24 |
| Average Concentration | 0.69 ± 0.13 | 0.64 ± 0.98 | 0.69 ± 0.11 |
| Minimum Concentration | 0.32 ± 0.04 | 0.35 ± 0.05 | 0.32 ± 0.04 |
| Maximum Concentration | 0.97 ± 0.09 | 1.09 ± 0.10 | 1.11 ± 0.10 |

Notes:

(1) The sediment is sampled to a depth of approximately 2.5 cm. The (±) values for minimum and maximum concentrations represent the statistical uncertainty at two standard deviations. The (±) values for average concentrations provide the 95% confidence interval for the average value. A value preceded by "<" is less than the decision level concentration. Average values preceded by "<" contain at least one value that is less than the decision level concentration.

(2) Plutonium concentration values are the sum of results for Pu-238, Pu-239 and Pu-240. Minimum and maximum concentrations preceded by "<" include at least one radionuclide concentration that is less than the decision level concentration in the sum of the radionuclides.

(3) Uranium concentration values are the sum of results for U-234, U-235 and U-238. Minimum and maximum concentrations preceded by "<" include at least one radionuclide concentration that is less than the decision level concentration in the sum of the radionuclides.

## TABLE 4-12 GAMMA SPECTROMETRY RESULTS FOR MOHAWK RIVER FISH, 2013

| Sample Location[(2)] | Fish Type (#) | No. of Samples | Radioactivity Concentrations (pCi/gm, wet weight)[(1)] K-40 Maximum | K-40 Average | Cs-137 Maximum | Cs-137 Average |
|---|---|---|---|---|---|---|
| Upstream | Carp (2)<br>Redhorse Sucker (2)<br>Carp (1) | 3 | 4.09 ± 0.38 | 3.43 ± 1.43 | < 0.01 | < 0.01 ± 0.01 |
| Upstream | Smallmouth Bass (2)<br>Smallmouth Bass (2) | 2 | 3.78 ± 0.36 | 3.72 ± 0.86 | < 0.01 | < 0.01 ± 0.01 |
| Downstream | White Sucker (1)<br>Carp (1)<br>Carp (1) | 3 | 3.34 ± 0.34 | 3.10 ± 0.57 | < 0.01 | < 0.01 ± 0.01 |
| Downstream | Largemouth Bass (2)<br>Smallmouth Bass (2) | 2 | 3.28 ± 0.35 | 3.27 ± 0.10 | < 0.01 | < 0.01 ± 0.01 |

Notes:

(1) A value preceded by "<" is less than the decision level concentration for that sample and parameter. Average values preceded by "<" contain at least one value that is less than the decision level concentration. The (±) value provides the statistical uncertainty at the 95% confidence interval.

(2) Upstream samples were obtained above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upstream respectively, from the Knolls Laboratory Outfall 002.) Downstream samples were obtained between the Knolls Laboratory Outfall 002 and Lock 7.

## TABLE 4-13 RADIOCHEMICAL ANALYSIS RESULTS FOR MOHAWK RIVER FISH, 2013

| Sample Location[(2)] | Fish Type (#) | Radioactivity Concentration[(1)] (pCi/g wet weight) Sr-90 | Plutonium[(3)] |
|---|---|---|---|
| Upstream | Redhorse Sucker (1) | 0.003 ± 0.004 | < 0.001 |
| Upstream | Small Mouth Bass (1) | 0.006 ± 0.004 | < 0.001 |
| Upstream | Carp (1) | < 0.003 | < 0.001 |
| Downstream | Walleye (1) | < 0.002 | < 0.001 |
| Downstream | Small Mouth Bass (1) | 0.004 ± 0.004 | < 0.001 |
| Downstream | Carp (1) | 0.004 ± 0.003 | < 0.001 |

Notes:

(1) A value preceded by "<" is less than the decision level concentration for that sample and parameter. The (±) value provides the statistical uncertainty at the 95% confidence interval.

(2) Upstream samples were obtained above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upstream respectively, from the Knolls Laboratory Outfall 002.) Downstream samples were obtained between the Knolls Laboratory Outfall 002 and Lock 7.

(3) Plutonium concentration values are the sum of results for Pu-238, Pu-239 and Pu-240.

### 4.4.4 Special Mohawk River Surveys

The Knolls Laboratory conducted an extensive sediment and biological sampling program of the Mohawk River during the summer of 1992 and again during the summer of 2002. These sampling programs were performed to update information on the quantity and distribution of radioactivity in the river sediment attributable to Knolls Laboratory operations prior to 1964 and to demonstrate that the residual radioactivity has no adverse effect on human health or the environment. Samples included numerous sediment core samples and various samples of fish, macrophyton, periphyton, plankton, benthic macroinvertebrates, and water. NYSDEC participated in the 2002 survey by observing the Knolls Laboratory sampling on the Mohawk River and splitting select core samples for independent analysis. The Knolls Laboratory also conducted a special sampling program consisting of only sediment core samples in 1981.

The results of the 1992 and 2002 sampling programs, as discussed in References (10) and (11), respectively, show that the distribution of residual radioactivity in the Mohawk River sediment in the vicinity of the Knolls Laboratory is well understood. The majority of radioactivity present is confined to an area along the south side of the Mohawk River, which extends from the Knolls Laboratory Outfall 002 to 1,000 feet downstream. The radioactivity generally is located at least 8 inches below the top of the sediment surface. Radioactivity concentrations above background levels are also detectable further downstream; however, the concentrations are lower, and the radioactivity is located even deeper in the sediment. Comparison of the 2002 sediment sampling results with those from 1992 and to those obtained from the similar survey done in 1981 shows that the 2002 results are similar to the 1992 results, though generally are lower than the 1981 results. The residual radioactivity remains deeper in the sediment than when surveyed in 1981, due to deposition of new sediment in the outfall area. Additionally, the NYSDEC split sample results for the 2002 survey were in very good agreement with the KAPL sample results.

A comparison was made between the total amount of residual radioactivity of Knolls Laboratory origin estimated to be present in the sediment above the Lock 7 dam for the 1981, 1992, and 2002 surveys. Though below the results from 1981 (with correction for radioactive decay), the 2002 survey results are not significantly different than the results obtained in 1992. The total radioactivity of Knolls Laboratory origin present in the sediment above the Lock 7 dam is considered to be the same as estimated from the 1992 study: less than 0.65 curies, of which 90% is attributable to cesium-137 and strontium-90 (and its short-lived daughter product yttrium-90). For perspective, the total radioactivity of Knolls Laboratory origin present in the sediment is less than 10% of the naturally occurring radioactivity found in the sediment in the same region.

The results of the fish and other biological sampling conducted show no detectable radioactivity of Knolls Laboratory origin above weapons testing fallout levels in any biological sample. These results continue to demonstrate that the residual radioactivity in the sediment is not being taken up in the food chain.

A radiological assessment of the residual radioactivity in the sediment concludes that, even using very conservative assumptions and hypothetical scenarios, no measurable dose to a member of the public would result, even if all of the radioactivity in the sediment were released back into the river water. The major conclusion of the radiological assessment is that the radioactivity of Knolls Laboratory origin continues to have no adverse effect on human health or the environment.

## 4.5 RADIATION MONITORING

The purpose of the environmental radiation monitoring program is to measure the ambient radiation levels around the Knolls Laboratory to confirm that operations have not altered the natural radiation background levels at the Knolls Laboratory perimeter. The sources of radiation at the Knolls Laboratory are from small specimens of irradiated and non-irradiated materials and from residual radioactivity remaining in facilities from historical operations.

**TABLE 4-14 PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KNOLLS LABORATORY, 2013**

| Monitoring Location(1) | Total Annual Exposure(2) (millirem) |
|---|---|
| 1 | 73 ± 3 |
| 2 | 67 ± 2 |
| 3 | 71 ± 3 |
| 4 | 78 ± 2 |
| 5 | 75 ± 3 |
| 6 | 67 ± 4 |
| 7 | 73 ± 3 |
| 8 | 73 ± 3 |
| 9 | 76 ± 3 |
| 10 | 68 ± 2 |
| 11 | 75 ± 3 |
| 12 | 75 ± 4 |
| 13 | 67 ± 3 |
| 14 | 72 ± 3 |
| 15 | 78 ± 2 |
| 16 | 69 ± 2 |
| Off-Site Locations | 69 ± 18 (3) |

Notes:
(1) See Figure 4-1 for perimeter monitoring locations.
(2) The (±) values for individual locations provide the 95% confidence interval for the exposure due to random uncertainty.
(3) Approximately 95% of off-site natural background measurements are expected to be within this range.

### 4.5.1 Scope

Environmental radiation levels were monitored at the perimeter of the Knolls Laboratory with a network of standard DT-702/PD lithium fluoride thermoluminescent dosimeters (TLDs). The sixteen locations of the Knolls Laboratory perimeter TLD monitors are shown in Figure 4-1. Control TLD monitors were also posted at remote off-site locations to measure the natural background levels typical of the surrounding area. All TLD monitors were posted for quarterly exposure periods.

### 4.5.2 Analyses

The environmental TLDs were calibrated to a cesium-137 standard source. The TLD radiation exposures were measured quarterly utilizing an automated TLD readout system which was calibrated prior to the processing of the TLDs.

### 4.5.3 Assessment

The results for the Knolls Laboratory perimeter and off-site radiation monitoring locations are summarized in Table 4-14. The average of the total annual exposures for each perimeter location is within the expected distribution of the off-site measurements at the 95% confidence interval. This shows that Knolls Laboratory operations in 2013 had no significant effect on natural background radiation levels at the Knolls Laboratory perimeter.

## 4.6 GROUNDWATER MONITORING

### 4.6.1 Scope

The Knolls Laboratory groundwater monitoring program includes routine monitoring of the closed Knolls Laboratory landfill, voluntary monitoring, and monitoring as part of the RCRA Corrective Action program.

Groundwater from twenty-six monitoring wells was sampled and analyzed for chemical quality and/or radioactivity in 2013. Thirteen groundwater monitoring wells are required by State and Federal regulations or agreements. Five wells (NTH-1A, NTH-2A, NTH-5A, W-11 and W-12) are associated with post-closure landfill groundwater monitoring. Four wells (SW-10, DW-09R, B-5, and B-6) are remediation assessment wells associated with evaluating the effectiveness of a soil remediation project in the former D3/D4 Yard area. Also, four wells (KH-6, KH-9S, KH-18, and KH-19) are associated with monitoring groundwater migration from an electrical High Yard area. The remaining groundwater monitoring wells are voluntarily installed and monitored by the Knolls Laboratory. Figure 4-1 is a map showing the locations of the Knolls Laboratory monitoring wells.

### 4.6.2 Sources

**Nonradiological:** Generally, groundwater underlying the Knolls Laboratory is contained in highly impermeable and nonporous soil and bedrock. As a consequence, there is only slight movement of the water, generally believed to be toward the northeast, to the Mohawk River. Due to the impermeable and nonporous nature of the soil and bedrock, there is no commercial or public development of the groundwater in the vicinity of the Knolls Laboratory. Groundwater contaminants can be introduced through two possible routes. The first route, surface recharging, carries atmospheric contaminants such as acid rain and airborne radioactivity from natural and manmade sources (such as past nuclear weapons testing), and surface contaminants from operational and historical land use (such as de-icing compounds, fertilizers, and pesticides). The second route is leaching of shallow nonradioactive buried wastes in the closed Knolls Laboratory landfill and other burial areas in the vicinity of the landfill where small amounts of waste chemicals from laboratory operations were buried many years ago, consistent with common industrial practices at the time.

**Radiological:** In some areas of the Knolls Laboratory, the soil contains low levels of radioactivity from operations over 45 years ago that is detectable above background levels. This has resulted in low levels of radioactivity in some of the on-site groundwater wells.

### 4.6.3 Analyses

**Nonradiological:** During 2013, the landfill wells were sampled twice, while the D3/D4 Yard remediation assessment wells and the High Yard area wells were sampled once, in accordance with regulatory agency (NYSDEC) agreements. The remaining wells were sampled once during 2013. Well DW-09 was removed during 2011 for a remediation project and was replaced with well DW-09R in 2012. The well was damaged in 2013 during a utility relocation and was unable to be sampled. KAPL formally reported this deviation to NYSDEC. Wells B-15, KH-16, and KH-17 were inaccessible due to SPRU work, wells B-26 and KH-15 were damaged by the SPRU hillside mudslide, and well MW-2 was damaged by a frost heave.

Table 4-15 summarizes the scope of the groundwater monitoring program. Table 4-16 lists the specific analyses for each chemical parameter group (field parameters, metals, and volatile organic compounds (VOCs)). For the voluntary program, the selection of wells and parameter groups is based on the historical groundwater monitoring program results, site operational history, well locations, and subsurface hydrogeologic information. For data discussion purposes, the wells are grouped into the following categories as listed in Table 4-15: Landfill, Land Area, Hillside, and Lower Level.

## TABLE 4-15 KNOLLS LABORATORY GROUNDWATER SAMPLING PROGRAM, 2013

| WELL CATEGORY | WELL ID | RADIOACTIVITY | MONITORING PARAMETER GROUP | | |
|---|---|---|---|---|---|
| | | | FIELD | METALS | VOCs |
| LANDFILL | NTH-1A | A | B | | B |
| | NTH-2A | A | B | | B |
| | NTH-5A | A | B | | B |
| | W-11 | A | B | | B |
| | W-12 | A | B | | B |
| LAND AREA | W-1 | A | A | A | A |
| | W-2 | A | A | A | A |
| | W-3 | A | A | A | A |
| | W-4 | A | A | A | A |
| | W-8 | A | A | A | A |
| | W-10 | A | A | A | A |
| | MW-2[1] | A | A | A | A |
| | MW-3 | A | A | A | A |
| | KH-2 | A | A | A | A |
| | KH-3S | A | | | |
| HILLSIDE | B-5 | A | A | | A |
| | B-6 | A | A | | A |
| | SW-10 | A | A | | A |
| | DW-09R[2] | A | A | | A |
| | B-15[3] | A | A | | A |
| | B-16 | A | A | | A |
| | B-26[4] | A | A | | A |
| | KH-6 | A | A | | A |
| | KH-9S | A | A | | A |
| | KH-15[4] | A | A | | A |
| | KH-16[3] | A | A | | A |
| | KH-17[3] | A | A | | A |
| | KH-18 | A | A | | A |
| LOWER LEVEL | KH-19 | A | A | | A |
| | KH-20 | A | | | |
| | KH-21 | A | A | | A |
| | KH-22 | A | A | | A |
| | KH-23 | A | A | | A |
| | Well point M[3] | A* | | | |
| | Well point N[3] | A* | | | |
| | Well point O[3] | A* | | | |

Notes:

A = Annually
B = Biannually
* = Tritium only
(1) Well MW-2 was damaged due to a frost heave and could not be sampled.
(2) Well DW-09R was damaged during a utility relocation and could not be sampled.
(3) Wells B-15, KH-16, KH-17, and well points M, N, and O were inaccessible due to SPRU work.
(4) Wells B-26 and KH-15 were damaged by the SPRU hillside mudslide and could not be sampled.

# TABLE 4-16 GROUNDWATER MONITORING PARAMETERS, 2013

| MONITORING PARAMETER GROUPS | | |
|---|---|---|
| **FIELD** | **METALS[1]** | **VOLATILE ORGANIC COMPOUNDS** |
| Static Water Level | Aluminum | EPA 601: |
| Specific Conductance | Antimony | Chloromethane |
| Temperature | Arsenic | Bromomethane |
| pH | Barium | Dichlorodifluoromethane |
| Turbidity[2] | Beryllium | Vinyl Chloride |
| | Boron | Chloroethane |
| | Cadmium | Methylene Chloride |
| | Calcium | Trichlorofluoromethane |
| | Chromium (total and hexavalent) | 1,1-Dichloroethane |
| | Copper | 1,1-Dichloroethylene |
| | Iron | trans-1,2-Dichloroethylene |
| | Lead | cis-1,2-Dichloroethylene |
| | Magnesium | Chloroform |
| | Manganese | 1,2-Dichloroethane |
| | Mercury | 1,1,1-Trichloroethane |
| | Nickel | Carbon Tetrachloride |
| | Potassium | Bromodichloromethane |
| | Selenium | 1,2-Dichloropropane |
| | Silver | trans-1,3-Dichloropropene |
| | Sodium | Trichloroethylene |
| | Thallium | Dibromochloromethane |
| | Zinc | 1,1,2-Trichloroethane |
| | | cis-1,3-Dichloropropene |
| | | Bromoform |
| | | 1,1,2,2-Tetrachloroethane |
| | | Tetrachloroethylene |
| | | Chlorobenzene |
| | | p-Dichlorobenzene |
| | | m-Dichlorobenzene |
| | | o-Dichlorobenzene |
| | | EPA 602:[3] |
| | | Benzene |
| | | Toluene |
| | | Ethylbenzene |
| | | Xylenes |
| | | EPA 624: [4] |
| | | Acetone |
| | | Hexane |

Notes:

(1) Analysis of metals (unfiltered and filtered) is performed voluntarily and only in the Land Area Wells.
(2) Measured in the laboratory and only for the Land Area Wells.
(3) EPA 602 parameters not required at the Landfill Wells.
(4) EPA 624 parameters required to be analyzed from B-5, B-6, DW-09R, and SW-10 per NYSDEC agreement.

As part of the NYSDEC-approved Knolls Laboratory Landfill Post-Closure Monitoring Program, Reference (7), the Knolls Laboratory monitors five overburden wells; one upgradient (NTH-1A) and four downgradient wells (NTH-2A, NTH-5A, W-11, and W-12). The parameters monitored under the revised monitoring plan (approved by NYSDEC and initiated in 2000) allow for adequate groundwater quality assessment based on the large historical database. Under a 1997 remediation agreement with NYSDEC, five wells (SW-10, DW-09R, B-5, B-6, and B-7) were monitored annually to assess the effectiveness of a soil remediation project in the former D3/D4 yard area. The soil remediation project entailed removal of soils containing VOCs and was driven by the need to construct a building at the Knolls Laboratory, and not by an environmental concern. Well DW-09R was damaged in 2013 during a utility relocation. The requirement to monitor well B-7 was removed under NYSDEC agreement in April 2008 to allow for a road modification project. Monitoring well B-7 was decommissioned during 2008, thereby reducing the soil remediation project assessment monitoring program to four wells. Also, under a 2004 agreement with NYSDEC to defer remediation of an electrical High Yard area until it is fully de-energized, four wells (KH-6, KH-9S, KH-18, and KH-19) are monitored for VOCs.

All field parameters except for turbidity are measured in the field using procedures provided in Standard Methods, Reference (8), or other EPA approved methods for analyzing chemical parameters. The vendor analytical laboratory is New York State (NYS) Environmental Laboratory Approval Program (ELAP) certified in potable water analyses and wastewater chemical analyses.

**Radiological:** The groundwater well samples are analyzed by the Knolls Laboratory for radiological parameters using the methods described in Section 4.2.3, Effluent Analyses.

### 4.6.4 Assessment

**Nonradiological:** Tables 4-17, 4-18, 4-19, and 4-20 summarize the 2013 groundwater monitoring nonradiological results. Generally, the majority of analytical results are indicative of natural groundwater quality. Most variations in the data are attributable to natural water quality, variability in laboratory results at or near the practical quantitation limit or interference associated with groundwater turbidity. The turbidity is the result of natural particulate materials entering the well from the surrounding clay and silt-rich geologic materials. Turbid water samples commonly show elevated metal results that are caused by particle mineralogy and are not indicative of dissolved, mobile metals.

All monitoring results are compared to the NYS groundwater standards provided in 6 NYCRR Part 703 for class GA groundwaters (Reference (1)). If no standard is provided, then the results are compared to the Guidance Values provided in the NYS Technical and Operational Guidance Series (1.1.1) Water Quality Standards and Guidance Values.

Table 4-20 summarizes the positive results of the VOC analyses. Only the parameters that were detected at or above the practical quantitation limit (PQL) by the laboratory are listed.

**<u>Landfill</u>**

The Knolls Laboratory Landfill well results are presented in Table 4-17. Specific conductance and pH were consistent with past monitoring results. Overall results for field parameters for the landfill wells are within representative ranges typical of the landfill area per Reference (12). VOCs were not detected at or above the PQL at any Landfill well locations.

**<u>Land Area</u>**

The Land Area data (Table 4-18) show natural water quality variations, the turbidity/elevated metal relationship, and road salting effects. Toxic metal results from all wells are less than the corresponding groundwater standard and are attributable to natural water quality. VOCs were not detected at or above the PQL at any Land Area well locations.

## Hillside

The Hillside groundwater monitoring consists of field parameters and VOC analysis. The field parameter data is consistent with the effects of natural groundwater compositional variations (Table 4-19). VOC results show the effects of former outdoor material storage practices on overburden water quality. VOC results (Table 4-20) for monitoring well B-5 are consistent with previous years. No VOCs were detected in monitoring wells downgradient of this well. An investigation of the Hillside revealed that the VOCs are mostly restricted to porous backfill associated with building foundations and utility lines, and are not migrating through indigenous soils.

## Lower Level

The Lower Level wells are installed in bedrock and are sampled for field parameters and VOCs. Field analysis data is shown in Table 4-19. The field data show the effects of natural groundwater compositional variations. The data are generally consistent with that reported previously. VOCs were not detected at or above the PQL at any Lower Level well locations.

**Radiological:** Results of the groundwater monitoring for radioactivity are summarized in Table 4-21. Due to SPRU work, wells B-15, KH-16, and KH-17, and the well points m, n, and o were not accessible and were not sampled in 2013. Some wells had slightly higher gross beta and/or gross alpha radioactivity than the background wells. This is attributed to slightly higher levels of dissolved naturally occurring uranium, thorium, and their respective daughter products. Naturally occurring potassium-40 would also contribute to the gross beta radioactivity. Strontium-90 was detected above background levels in several wells. Strontium-90 and its daughter product, yttrium-90, also contribute to the gross beta radioactivity. All gross alpha, gross beta, strontium-90, and tritium results were generally within the range of previously reported values. The maximum concentration of strontium-90, which has the most restrictive derived concentration guide of any radionuclide measured in any well, was detected in well KH-21. The KH-21 strontium-90 concentration was less than one percent of the DOE derived concentration guide (Reference (4)).

## Conclusion

The overall conclusion of the groundwater monitoring program is that previous operations and waste disposal practices have resulted in some small, measurable effects on the groundwater quality in localized areas of the Knolls Laboratory. Based on upstream and downstream monitoring of the Mohawk River, there is no detectable effect on river water quality as a result of past or current Knolls Laboratory operations. The groundwater is limited in quantity and is not used as a drinking water supply. In addition, the Knolls Laboratory is not located over any principal or primary bedrock or overburden aquifers. Therefore, the groundwater associated with the Knolls Laboratory does not pose any threat to public health.

## TABLE 4-17 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LANDFILL WELLS, 2013

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| Well Location | Sample Date | Parameter: Water Level Elevation (feet)[1] | Temperature (C) | pH (su) | Specific Conductance (µmhos/cm) | VOCs[2] (µg/l) |
|---|---|---|---|---|---|---|
| **NTH-1A[3]** | 04/29/13 | 320.22 | 8.0 | 6.4 | 370 | <1.0 |
| | 10/29/13 | 312.76 | 11.1 | 7.3 | 737 | <1.0 |
| **NTH-2A** | 04/29/13 | 233.46 | 7.7 | 7.0 | 1,109 | <1.0 |
| | 10/29/13 | 233.40 | 11.7 | 7.2 | 1,460 | <1.0 |
| **NTH-5A** | 04/29/13 | 269.62 | 8.3 | 6.3 | 327 | <1.0 |
| QA Duplicate | 04/29/13 | NA | NA | NA | NA | <1.0 |
| | 10/29/13 | 263.87 | 11.4 | 7.2 | 763 | <1.0 |
| QA Duplicate | 10/29/13 | NA | NA | NA | NA | <1.0 |
| **W-11** | 04/29/13 | 258.29 | 6.9 | 6.9 | 1,548 | <1.0 |
| | 10/29/13 | 256.87 | 12.1 | 7.1 | 1,126 | <1.0 |
| **W-12** | 04/29/13 | 241.28 | 7.0 | 6.7 | 717 | <1.0 |
| | 10/29/13 | 238.51 | (8) | (8) | (8) | <1.0 |
| FIELD BLANK (NTH-5A) | 04/29/13 | NA | NA | NA | NA | <1.0 |
| FIELD BLANK (NTH-5A) | 10/29/13 | NA | NA | NA | NA | <1.0 |
| STANDARDS [4] | | [5] | [5] | 6.5-8.5[6] | [5] | [7] |

Notes:

NA – Not Applicable.

(1) The latest site-wide topological mapping project results were used for the groundwater elevation calculations.
(2) See Table 4-16 for a listing of the Volatile Organic Compounds (VOCs). Landfill wells are analyzed for VOCs only using EPA Method 601. A value preceded by "<" is less than the practical quantitation limit.
(3) Up-gradient well.
(4) Water Quality Standards, 6 NYCRR Parts 700-705.
(5) No standard or guidance value available.
(6) Per the NYSDEC-approved Post-Closure Landfill Monitoring Plan, the acceptable pH range is 6.0 – 9.0.
(7) Standards vary between 0.4 µg/l and 50 µg/l.
(8) Inadequate recharge to produce a sample to determine field parameters.

# TABLE 4-18 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS, 2013

| | | Parameter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Field Parameters | | | | | Metals[1,2] | | | | |
| Well | Sample Date | Water Level Elevation (ft) | Temperature (C) | pH (su) | Specific Conductance (μmhos/cm) | Turbidity (ntu) | Aluminum (mg/l) | Antimony (mg/l) | Arsenic (mg/l) | Barium (mg/l) | Beryllium (mg/l) |
| KH-2 | 01/28/13 | 322.44 | 9.4 | 6.3 | 5,127 | 22,000 | 2.98 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.300 / 0.288 | <0.005 / <0.005 |
| MW-2 | 01/28/13 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| MW-3 | 01/28/13 | 313.74 | 5.6 | 6.0 | 3,458 | 98 | 3.16 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.157 / 0.108 | <0.005 / <0.005 |
| W-1 | 01/28/13 | 317.88 | 9.8 | 6.8 | 2,627 | 14 | <0.100 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.171 / 0.163 | <0.005 / <0.005 |
| W-2 | 01/28/13 | 305.06 | 9.4 | 6.6 | 1,897 | 320 | 2.79 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.111 / 0.071 | <0.005 / <0.005 |
| W-3 | 01/28/13 | 296.96 | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| W-4 | 01/28/13 | 282.57 | 7.8 | 6.5 | 1,212 | 9,100 | 5.44 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.108 / 0.054 | <0.005 / <0.005 |
| W-4, Duplicate | 01/28/13 | NA | NA | NA | NA | NA | 3.85 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.091 / 0.053 | <0.005 / <0.005 |
| W-8 | 10/29/13 | 301.91 | 10 | 8.7 | 506 | 124 | 0.194 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.125 / 0.106 | <0.005 / <0.005 |
| W-8, Duplicate | 10/29/13 | NA | NA | NA | NA | NA | 0.206 /<0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.123 / 0.107 | <0.005 / <0.005 |
| W-10 | 01/28/13 | 287.21 | 7.7 | 6.7 | 803 | 13 | <0.100 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | 0.033 / 0.035 | <0.005 / <0.005 |
| FIELD BLANKS (W-4) | 01/28/13 | NA | NA | NA | NA | 0.2 | <0.100 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | <0.010 / <0.010 | <0.005 / <0.005 |
| FIELD BLANKS (W-8) | 10/29/13 | NA | NA | NA | NA | NA | <0.100 / <0.100 | <0.060 / <0.060 | <0.005 / <0.005 | <0.010 / <0.010 | <0.005 / <0.005 |
| STANDARDS [3] | | [4] | [4] | 6.5-8.5 | [4] | 5 | [4] | 0.003 | 0.025 | 1 | 0.003[5] |

Notes:

NA – Not Applicable.

NS – Not Sampled, MW-2 well damaged; W-3 no recovery.

(1) A value preceded by "<" is less than the practical quantitation limit.
(2) Unfiltered / Filtered results.
(3) Water Quality Standards, 6 NYCRR 703.
(4) No groundwater standard or guidance value available.
(5) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(6) Hexavalent chromium results are unfiltered, per Standard Method 3500Cr-D.
(7) Combined concentration of iron and manganese shall not exceed 0.5 mg/l per 6 NYCRR 703.
(8) Standards vary between 0.4 μg/l and 50 μg/l.

## TABLE 4-18 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS, 2013 (Continued)

| | | Metals[1,2] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Well | Sample Date | Boron (mg/l) | Cadmium (mg/l) | Calcium (mg/l) | Chromium (mg/l) | Chromium, VI[6] (mg/l) | Copper (mg/l) | Iron (mg/l) | Lead (mg/l) | Magnesium (mg/l) | Manganese (mg/l) |
| KH-2 | 01/28/13 | <0.050 / <0.050 | <0.005 / <0.005 | 416 / 350 | <0.005 / <0.005 | <0.02 | 0.006 / <0.005 | 8.06 / <0.050 | <0.005 / <0.005 | 74.0 / 74.1 | 0.263 / 0.171 |
| MW-2 | 01/28/13 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| MW-3 | 01/28/13 | <0.050 / 0.065 | <0.005 / <0.005 | 232 / 259 | <0.005 / <0.005 | <0.02 | 0.010 / <0.005 | 14.5 / <0.050 | 0.007 / <0.005 | 39.3 / 40.6 | 5.25 / 0.084 |
| W-1 | 01/28/13 | 0.060 / 0.074 | <0.005 / <0.005 | 169 / 160 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | 0.173 / 0.084 | <0.005 / <0.005 | 41.2 / 38.6 | 0.140 / 0.129 |
| W-2 | 01/28/13 | 0.332 / 0.310 | <0.005 / <0.005 | 293 / 179 | <0.005 / <0.005 | <0.02 | 0.010 / <0.005 | 6.26 / <0.050 | 0.005 / <0.005 | 65.9 / 56.0 | 0.712/ 0.530 |
| W-3 | 01/28/13 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| W-4 | 01/28/13 | 0.063 / 0.071 | <0.005 / <0.005 | 154 / 150 | <0.005 / <0.005 | <0.02 | 0.012 / <0.005 | 13.4 / <0.050 | 0.007 / <0.005 | 46.2 / 41.4 | 0.404 / 0.145 |
| W-4, Duplicate | 01/28/13 | 0.065 / 0.072 | <0.005 / <0.005 | 148 / 151 | 0.005 / <0.005 | <0.02 | 0.007 /<0.005 | 9.43 / <0.050 | 0.006 / <0.005 | 43.4 / 41.2 | 0.330 / 0.142 |
| W-8 | 10/29/13 | 0.265 / 0.266 | <0.005 / <0.005 | 39.8 / 37.5 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | 0.732 / <0.050 | <0.005 / <0.005 | 10.7 / 10.4 | 0.102 / 0.058 |
| W-8, Duplicate | 10/29/13 | 0.267 / 0.256 | <0.005 / <0.005 | 40.5 / 37.8 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | 0.727 / <0.050 | <0.005 / <0.005 | 10.8 / 10.5 | 0.106 / 0.060 |
| W-10 | 01/28/13 | 0.073 / 0.078 | <0.005 / <0.005 | 80.6 / 90.7 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | 0.105 / <0.050 | <0.005 / <0.005 | 25.3 / 27.2 | 0.128 / 0.104 |
| FIELD BLANKS (W-4) | 01/28/13 | <0.050 / <0.050 | <0.005 / <0.005 | <0.050 / 0.097 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | <0.050 / <0.050 | <0.005 / <0.005 | <0.050 / <0.050 | <0.020 / <0.020 |
| FIELD BLANKS (W-8) | 10/29/13 | <0.050 / <0.050 | <0.005 / <0.005 | <0.050 / <0.050 | <0.005 / <0.005 | <0.02 | <0.005 / <0.005 | <0.050 / <0.050 | <0.005 / <0.005 | <0.050 / <0.050 | <0.020 / <0.020 |
| STANDARDS [3] | | 1 | 0.005 | [4] | 0.050 | 0.05 | 0.2 | 0.3[7] | 0.025 | 35[6] | 0.3[7] |

Notes:

NA – Not Applicable.
NS – Not Sampled, MW-2 well damaged; W-3 no recovery.
(1) A value preceded by "<" is less than the practical quantitation limit.
(2) Unfiltered / Filtered results.
(3) Water Quality Standards, 6 NYCRR 703.
(4) No groundwater standard or guidance value available.
(5) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(6) Hexavalent chromium results are unfiltered, per Standard Method 3500Cr-D.
(7) Combined concentration of iron and manganese shall not exceed 0.5 mg/l per 6 NYCRR 703.
(8) Standards vary between 0.4 µg/l and 50 µg/l.

## TABLE 4-18 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS, 2013 (Continued)

| | | Parameter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Metals[1,2] | | | | | | | | Organics |
| Well | Sample Date | Mercury (mg/l) | Nickel (mg/l) | Potassium (mg/l) | Selenium (mg/l) | Silver (mg/l) | Sodium (mg/l) | Thallium (mg/l) | Zinc (mg/l) | VOCs[8] (µg/l) |
| KH-2 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 62.3 / 72.0 | <0.005 / <0.005 | <0.010 / <0.010 | 464 / 400 | <0.010 / <0.010 | 0.070 / 0.053 | <1.0 |
| MW-2 | 01/28/13 | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| MW-3 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 2.43 / 0.852 | <0.005 / <0.005 | <0.010 / <0.010 | 312 / 331 | <0.010 / <0.010 | 0.023 / <0.010 | <1.0 |
| W-1 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 5.39 / 5.46 | <0.005 / <0.005 | <0.010 / <0.010 | 261 / 262 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| W-2 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 8.73 / 7.80 | <0.005 / <0.005 | <0.010 / <0.010 | 118 / 97.4 | <0.010 / <0.010 | 0.013 / <0.010 | <1.0 |
| W-3 | 01/28/13 | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| W-4 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 4.36 / 2.25 | <0.005 / <0.005 | <0.010 / <0.010 | 29.8 / 30.2 | <0.010 / <0.010 | 0.027 / <0.010 | <1.0 |
| W-4, Duplicate | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 3.74 / 2.23 | <0.005 / <0.005 | <0.010 / <0.010 | 29.3 / 29.9 | <0.010 / <0.010 | 0.021 / <0.010 | <1.0 |
| W-8 | 10/29/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 3.19 / 3.08 | <0.005 / <0.005 | <0.010 / <0.010 | 34.6 / 33.9 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| W-8, Duplicate | 10/29/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 3.20 / 3.09 | <0.005 / <0.005 | <0.010 / <0.010 | 35.0 / 34.5 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| W-10 | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | 3.50 / 3.86 | <0.005 / <0.005 | <0.010 / <0.010 | 34.4 / 36.9 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| FIELD BLANKS (W-4) | 01/28/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | <0.050 / <0.050 | <0.005 / <0.005 | <0.010 / <0.010 | <0.050 / <0.050 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| FIELD BLANKS (W-8) | 10/29/13 | <0.0002 / <0.0002 | <0.020 / <0.020 | <0.050 / <0.050 | <0.005 / <0.005 | <0.010 / <0.010 | <0.050 / <0.050 | <0.010 / <0.010 | <0.010 / <0.010 | <1.0 |
| STANDARDS [3] | | 0.0007 | 0.10 | [4] | 0.010 | 0.05 | 20 | 0.0005[6] | 2.0[6] | [4] |

Notes:

NA – Not Applicable.
NS – Not Sampled, MW-2 well damaged; W-3 no recovery.
(1) A value preceded by “<” is less than the practical quantitation limit.
(2) Unfiltered / Filtered results.
(3) Water Quality Standards, 6 NYCRR 703.
(4) No groundwater standard or guidance value available.
(5) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(6) Hexavalent chromium results are filtered, per Standard Method 3500Cr-D.
(7) Combined concentration of iron and manganese shall not exceed 0.5 mg/l per 6 NYC RR 703.
(8) Standards vary between 0.4 µg/l and 50 µg/l.

## TABLE 4-19 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF HILLSIDE AREA AND LOWER LEVEL WELLS, 2013

| Locations | Sample Date | Water Level Elevation (ft) | Temperature (C) | pH (su) | Specific Conductance (µmhos/cm) | Volatile Organic Compounds (µg/l)[1] |
|---|---|---|---|---|---|---|
| **Hillside Area** | | | | | | |
| B-5 | 1/29/2013 | 324.38 | 17.3 | 6.8 | 5,215 | See Table 4-20 |
| B-5 Duplicate | 1/29/2013 | NA | NA | NA | NA | See Table 4-20 |
| B-6 | 1/29/2013 | 322.34 | 16.1 | 6.9 | 2,422 | <1.0 |
| SW-10 | 1/29/2013 | 326.23 | 11.8 | 7.1 | 3,426 | <1.0 |
| B-16 | 1/28/2013 | 269.57 | 6.3 | 6.4 | 2,629 | <1.0 |
| B-16 Duplicate | 1/28/2013 | NA | NA | NA | NA | <1.0 |
| KH-6 | 1/29/2013 | 315.2 | 10.4 | 6.5 | 740 | <1.0 |
| KH-9S | 1/29/2013 | 325.35 | 10.1 | 6.6 | 3,003 | <1.0 |
| KH-16[2] | NA | NA | NA | NA | NA | NA |
| KH-17[2] | NA | NA | NA | NA | NA | NA |
| KH-18 | 1/29/2013 | 283.26 | 6.9 | 6.5 | 803 | <1.0 |
| **Lower Level** | | | | | | |
| KH-19 | 1/29/2013 | 235.47 | 9.8 | 8.4 | 1,110 | <1.0 |
| KH-21 | 1/28/2013 | 242.12 | 11.7 | 6.4 | 4,467 | <1.0 |
| KH-22 | 1/28/2013 | 220.39 | 11.2 | 6.5 | 1,734 | <1.0 |
| KH-23 | 1/28/2013 | 241.42 | 9.5 | 7.1 | 1,739 | <1.0 |
| **Field Blanks** | | | | | | |
| B-16 | 1/28/2013 | NA | NA | NA | NA | <1.0 |
| B-5 | 1/29/2013 | NA | NA | NA | NA | <1.0 |

Notes:
NA – Not Applicable.
(1) A value preceded by "<" is less than the practical quantitation limit.
(2) Due to DOE-EM/SPRU work, the well was not accessible and thus not sampled.

# TABLE 4-20 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING, DETECTABLE VOLATILE ORGANIC ANALYSIS, 2013

| | | Parameter Volatile Organic Compounds[1] | | | | |
|---|---|---|---|---|---|---|
| Well | Sample Date | Vinyl Chloride (µg/l) | 1,1-Dichloroethene (µg/l) | Trans-1,2-Dichloroethene (µg/l) | cis-1,2,-Dichloroethene (µg/l) | Trichloroethene (µg/l) |
| B-5 | 01/29/13 | 5.6 | 13 | 2.7 | 180 | 1700 |
| B-5, Duplicate | 01/29/13 | 5.5 | 12 | 2.7 | 180 | 1700 |
| Field Blank (B-5) | 01/29/13 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Standards[2] | | 2 | 5 | 5 | 5 | 5 |

Notes:
(1) See Table 4-16 for the complete list of VOCs that were analyzed. A value preceded by "<" is less than the practical quantitation limit. The results for those parameters not listed in this table were all less than the practical quantitation limit.
(2) Water Quality Standards, 6 NYCRR 703.5.

## TABLE 4-21 RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING FOR RADIOACTIVITY, 2013

| Locations | | Gross Beta | Gross Alpha | Sr-90 | Cs-137 | H-3 |
|---|---|---|---|---|---|---|
| | | Radioactivity Concentrations[1,2] | | | | |
| | | pCi/liter | | | | (x $10^2$ pCi/l) |
| **Landfill Area** | | | | | | |
| November | NTH-1A | 1.7 ± 1.3 | < 0.9 | 0.4 ± 0.2 | < 0.4 | < 1.0 |
| | NTH-2A | 6.6 ± 3.3 | 3.7 ± 4.5 | 0.7 ± 0.3 | < 0.5 | < 1.0 |
| | NTH-5A | 3.5 ± 1.7 | < 1.2 | < 0.2 | < 0.4 | < 1.0 |
| | W-11 | 6.1 ± 3.1 | < 1.8 | < 0.1 | < 0.4 | < 1.0 |
| | W-12 | 7.7 ± 3.4 | 0.3 ± 0.4 | 0.8 ± 0.3 | < 1.0 | < 1.0 |
| **Land Area** | | | | | | |
| January | W-2 | 3.6 ± 4.0 | < 4.8 | < 0.2 | < 0.5 | < 1.0 |
| | W-3 | 3.3 ± 1.4 | < 1.5 | < 0.2 | < 0.5 | < 1.0 |
| | W-4 | 3.6 ± 2.9 | < 3.2 | < 0.2 | < 0.4 | < 1.0 |
| November | W-8 | 6.1 ± 1.7 | 1.6 ± 1.7 | < 0.2 | < 0.5 | < 1.0 |
| January | W-10 | 1.6 ± 1.8 | 2.6 ± 3.9 | < 0.2 | < 0.5 | < 1.0 |
| | MW-3 | < 5.5 | < 8.7 | < 0.2 | < 0.4 | < 1.0 |
| **Hillside Area** | | | | | | |
| January | B-5 | < 6.7 | < 14.5 | < 0.2 | < 0.4 | < 1.0 |
| | B-6 | 4.0 ± 3.3 | < 3.7 | 0.2 ± 0.2 | < 0.5 | < 1.0 |
| | B-16 | < 4.3 | < 7.4 | < 0.2 | < 0.4 | < 1.0 |
| | KH-6 | 4.3 ± 2.5 | < 2.8 | < 0.2 | < 0.5 | < 1.0 |
| | KH-9S | < 4.5 | < 6.0 | < 0.2 | < 0.4 | < 1.0 |
| | KH-18 | 6.3 ± 3.0 | 2.8 ± 4.2 | 0.3 ± 0.2 | < 0.5 | < 1.0 |
| | SW-10 | 5.9 ± 2.8 | < 2.9 | 0.2 ± 0.2 | < 0.5 | < 1.0 |
| **Lower Level** | | | | | | |
| January | KH-19 | 3.8 ± 2.6 | 2.9 ± 4.4 | < 0.2 | < 0.4 | < 1.0 |
| | KH-20 | < 2.8 | < 3.7 | < 0.2 | < 0.5 | < 1.0 |
| | KH-21 | 16.6 ± 8.3 | 16.0 ± 15.6 | 6.0 ± 0.6 | < 0.4 | < 1.0 |
| | KH-22 | 4.3 ± 4.3 | < 4.5 | 0.8 ± 0.3 | < 0.5 | < 1.0 |
| | KH-23 | 2.8 ± 2.8 | < 2.9 | < 0.3 | < 0.5 | < 1.0 |
| **Background Wells - for comparison** | | | | | | |
| January | W-1 | < 4.1 | < 6.3 | < 0.2 | < 0.4 | < 1.0 |
| | KH-2 | 16.3 ± 7.8 | < 9.0 | 0.7 ± 0.3 | < 0.5 | < 1.0 |
| | KH-3S | 2.3 ± 1.7 | < 2.1 | < 0.2 | < 0.4 | < 1.0 |

Notes:
(1) A value preceded by "<" is less than the decision level concentration for that sample and parameter. The (±) value represents the statistical uncertainty at the 95% confidence interval.
(2) The lowest possible value for any parameter is zero.

## 4.7 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES AND SOLID WASTE

### 4.7.1 Sources

Chemicals are not manufactured at the Knolls Laboratory. Minimal quantities of hazardous wastes do result from the necessary use of chemicals in Knolls Laboratory operations. To ensure the safe use of chemicals and disposal of the resulting wastes, the Knolls Laboratory maintains a hazardous waste control program. Hazardous wastes are disposed of through permitted off-site treatment and disposal facilities.

### 4.7.2 Chemical Control Program

The control program minimizes the quantity of waste material generated, ensures safe usage and storage of the materials at the Knolls Laboratory, and provides for proper disposal of the wastes by vendors that operate under permits issued by Federal and State agencies.

A principal part of the waste minimization program is the control of the acquisition of hazardous substances for use at the Knolls Laboratory. Purchase orders for chemicals are reviewed to ensure that the materials are actually necessary for Knolls Laboratory operations, that the amount ordered is not excessive, and that methods for proper disposal are in place before the material is ordered. Hazardous substance storage controls include, as a minimum: labeling, providing revetment as appropriate, segregation based on compatibility, limited storage volumes, and weather protection as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations (Reference (13)) and the Petroleum Bulk Storage regulations (Reference (14)). The Knolls Laboratory currently does not store any chemicals in quantities that are subject to the Chemical Bulk Storage regulations.

Additionally, many hazardous substances have been replaced by non-hazardous substitutes. KAPL stresses the "Know Before Do" principle. To this end, facility personnel must identify ways to minimize waste prior to performing a waste generating process. KAPL also evaluates the hazardous waste that is generated and determines if additional waste minimization can be achieved. Prior to 2000, the Knolls Laboratory provided NYSDEC with an annual Hazardous Waste Reduction Plan. However, due to successful waste minimization efforts, the small quantity of routine hazardous waste currently generated at the Knolls Laboratory falls below the threshold established by NYSDEC for submittal of this formal plan. Significant reductions in hazardous waste streams have been accomplished since the early 1990s. The replacement of the Knolls Laboratory Boiler House strong-acid regenerated cation make-up water treatment system with a water softener and de-alkalizer treatment system have resulted in over a 90% reduction of the hazardous waste generated at the Knolls Laboratory since 1994. In the past, significant reductions were also achieved at the Knolls Laboratory hazardous photographic waste streams by the installation of silver recovery units and the replacement of some photographic waste streams with a dry type laser system. Today, photographic techniques at the Knolls Laboratory use digital technology so that little or no photographic processes rely on wet chemistry using silver bearing compounds.

All personnel working at the Knolls Laboratory are provided with general information on the Knolls Laboratory policies for the procurement, use, and disposal of hazardous substances. For individuals who use hazardous substances in operations, specific training is provided to ensure that they are knowledgeable of safe handling techniques and emergency response procedures. After chemicals are used and no longer needed, they are accumulated in designated staging and storage areas where they are segregated and packaged for shipment. Waste is temporarily stored only as necessary to accumulate sufficient volumes for shipment to a waste disposal vendor. Hazardous and mixed (radioactive and hazardous) waste storage facilities are operated at the Knolls Laboratory under a permit obtained from NYSDEC. The Knolls Laboratory has an inspection program to routinely verify that hazardous substances are properly stored and controlled in accordance with approved procedures.

In addition, the Knolls Laboratory hazardous waste control program is subject to an annual on-site inspection. The EPA conducted the hazardous waste management inspection during 2013.

### 4.7.3 Chemical Disposal

Hazardous waste is managed in compliance with the Resource Conservation and Recovery Act (RCRA). Generated waste is transported by vendors to treatment/storage/disposal facilities for final disposition. The transportation vendors and the treatment/storage/disposal facilities operate under permits issued by the cognizant Federal and State regulatory agencies. KAPL requires the disposal facilities to provide itemized written verification that the waste was actually received. During 2013, the Knolls Laboratory shipped approximately 10.6 tons of RCRA and New York State hazardous waste off-site for disposal. This includes approximately 1.7 tons of mixed waste. The Knolls Laboratory reduces the potential environmental impact of the waste by selecting the ultimate disposal methods that minimize or eliminate future environmental intrusion.

Non-hazardous chemical waste is also sent off-site for disposal. The transportation vendors and the treatment/storage/disposal facilities are typically the same as those used for hazardous waste disposal. These facilities also operate under permits issued by the cognizant Federal and State regulatory agencies. KAPL requires the disposal facility to provide itemized written verification that the waste was actually received. Approximately 187.2 tons of non-hazardous chemical waste was sent for off-site disposal via incineration, wastewater treatment, chemical treatment, or land disposal from the Knolls Laboratory.

### 4.7.4 Solid Waste Disposal/Recycling

During 2013, approximately 1073 tons of non-hazardous solid waste were generated from such waste streams as office and cafeteria trash, construction and demolition debris, and classified scrap paper. KAPL also recycles solid waste streams such as; glass, tin, aluminum, newspapers, magazines, plastic, cardboard, wood, asphalt, lead, concrete, precious metals, computers, metal and plastic drums, cafeteria grease, recycled oil, fluorescent light bulbs, and batteries. Approximately 640 tons of these materials were recycled from the Knolls Laboratory in 2013.

## 4.8 CONTROL OF RADIOACTIVE MATERIALS AND RADIOACTIVE WASTE

### 4.8.1 Sources

Operation of the Knolls Laboratory results in the generation of various types of radioactive materials and wastes. Low level radioactive solid waste materials that require disposal include filters, metal scrap, rags, resin, paper, and plastic materials.

### 4.8.2 Control Program

Detailed procedures are used for handling, packaging, transportation, and for disposal of radioactive waste at a government operated or licensed disposal site. Internal reviews are made prior to the shipment of any radioactive material from the Knolls Laboratory to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal requirements.

The volume of radioactive waste is minimized through the use of special work procedures that limit the amount of materials that become contaminated during work on radioactive systems and components. Radioactive liquid waste is collected in an absorbed form prior to shipment to an approved disposal facility. All radioactive wastes are prepared and shipped in accordance with written procedures to meet the applicable DOT regulations given in Reference (15). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

### 4.8.3 Disposal/Recycling

The shipments of low level radioactive solid wastes were made by authorized common carriers to disposal sites located outside New York State.

During 2013, approximately 279 cubic meters (364 cubic yards) of low level radioactive waste containing approximately 2.7 curies were shipped from the Knolls Laboratory for disposal. The Knolls Laboratory shipped approximately 7.1 tons of slightly radioactive metal to an out-of-state radioactive material recycling facility for controlled reuse.

## 4.9 CONTROL OF MIXED WASTES

### 4.9.1 Sources

A mixed waste is a waste that contains radioactive and hazardous components, as defined by the Atomic Energy Act (AEA) and the Resource Conservation and Recovery Act (RCRA). Also, per NYSDEC, certain Toxic Substances Control Act (TSCA) regulated PCB waste is also considered a hazardous waste. Operations at the Knolls Laboratory, in support of research and development for the design and operation of naval nuclear propulsion plants, resulted in the generation of a small quantity of mixed wastes. These wastes included laboratory chemicals, oils, equipment, and debris.

### 4.9.2 Control Program

Mixed wastes were managed in accordance with the Knolls Laboratory RCRA permit, the Knolls Laboratory Treatment Plan, which is updated annually and provided to NYSDEC, and the Federal Facility Compliance Act of 1992. The Knolls Laboratory takes aggressive action to minimize the creation of mixed waste by reducing the commingling of radioactive and hazardous materials and avoiding the use of hazardous substances where technically acceptable. The amount of generated mixed waste was also minimized through the use of detailed work procedures and worker training.

### 4.9.3 Storage and Disposal

Mixed wastes were accumulated in designated regulated and permitted storage areas. The wastes were packaged for storage and shipment to off-site treatment facilities in accordance with the Knolls Laboratory Treatment Plan. In 2013, there were three shipments totaling approximately 1.7 tons of various mixed wastes to treatment and disposal facilities.

## 4.10 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 2013 operations at the Knolls Laboratory and SPRU had no measurable effect on normal background radioactivity levels. Therefore, any radiation doses from the Knolls Laboratory and SPRU operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of the radiation dose to the maximally exposed individual in the vicinity of the Knolls Laboratory, including SPRU and the collective dose to the population residing in the 80 kilometer (50 mile) radius assessment area are summarized in Section 7.0, Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the radiation protection standards of the DOE listed in Reference (4) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Knolls Laboratory was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole-body dose, demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions from both the Knolls Laboratory and SPRU was less than one percent of the EPA standard in Reference (6).

The collective radiation dose to the public along the travel route from Knolls Laboratory shipments of radioactive materials during 2013 was calculated using data given by the NRC in Reference (17). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. (See Section 6.10 for collective radiation dose from SPRU shipments.) This is less than 0.001 percent of the dose received by the same population from natural background radiation.

# 5.0 KESSELRING SITE ENVIRONMENTAL MONITORING

## 5.1 SITE DESCRIPTION

The Kesselring Site consists of 3,900 acres on which two operating pressurized-water naval nuclear propulsion plants and support facilities are located, including administrative offices, machine shops, waste storage facilities, oil storage facilities, training facilities, equipment service buildings, chemistry laboratories, a boiler house, cooling towers, and wastewater treatment facilities. Two other nuclear propulsion plants were permanently shut down during the 1990s; one has been dismantled, the other is undergoing dismantlement. The Site is located near West Milton, New York, approximately 17 miles (27.4 kilometers) north of the City of Schenectady, and 9 miles (14.5 kilometers) southwest of Saratoga Springs (see Figure 2-1). The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

As a result of the end of the Cold War and the downsizing of the Navy, the S3G and D1G Prototype reactor plants were shut down in May 1991 and March 1996, respectively. All spent nuclear fuel was removed from the S3G Prototype reactor and shipped off-site in July 1994. All spent nuclear fuel was removed from the D1G Prototype reactor and shipped off-site in February 1997. After completion of the public National Environmental Policy Act process in 1998, a record of decision was issued for prompt dismantlement of the defueled S3G and D1G reactor plants. Dismantlement operations began, starting on the S3G plant, shortly after this decision was made. Dismantlement of the S3G plant was completed during 2006 and dismantlement of the D1G plant is continuing. The project is planned to be completed as soon as practicable subject to available appropriated funding. Two additional nuclear propulsion plants, the S8G and MARF Prototypes, will continue to be operated at the Site for the foreseeable future.

The climate in the region of the Kesselring Site is primarily continental in character, but is subjected to some modification from the maritime climate, which prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally fairly severe. Maximum temperatures during the colder winter months often are below freezing and nighttime low temperatures frequently drop to $10^0$F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 65 inches per year. Over some of the higher elevation areas nearby, snowfall ranges up to 75 inches or more for a season. The mean annual precipitation for the area is approximately 36 inches per year. The prevailing winds are from the west.

The area surrounding the Kesselring Site has a complex geological history due to the processes of erosion, glaciation, folding, and faulting. The geological formations of the West Milton area are comprised of two major types; bedrock, which ranges in age from Precambrian to Ordovician, and unconsolidated deposits of Pleistocene and Recent age. Bedrock underlying the area crops out only on some steep hillsides and in some stream valleys. It is covered by the unconsolidated deposits in the remainder of the area. These unconsolidated deposits range in thickness from zero to 200 feet with an average thickness of 50 feet. Bedrock underlying the West Milton area may be divided into two groups; (1) metamorphosed rocks of Precambrian age, and (2) sedimentary rocks of Paleozoic age. The older metamorphosed rocks consist of gneiss, schist, quartzite, and limestone (marble) of sedimentary origin; and syenite and granite of igneous origin. These rocks are referred to as crystalline rocks. The Paleozoic rocks likewise consist of several types of rocks including sandstone, dolomite, limestone, and shale. The unconsolidated deposits can be subdivided into four groups: (1) till - an unstratified, dense heterogeneous mixture of glacially deposited rock particles ranging in size from clay to gravel, (2) ice-contact deposits - kames and eskers composed of stratified sand and gravel, (3) glaciolacustrine deposits - a homogeneous stratified layer of sand, silt, and clay; and (4) recent fluvial deposits consisting of sand and gravel.

Generally, the coarser grained, stratified, unconsolidated deposits form better aquifers than the fine grained and unstratified unconsolidated deposits or bedrock foundations. Only small areas are underlain by these coarse grained deposits. Percolating water from rainfall and snowmelt recharge the shallow, unconfined aquifers beneath the Site, and in turn streams are recharged by shallow groundwater. The Kayaderosseras Creek is underlain by coarse grained glacial and fluvial valley-fill deposits from which all Kesselring Site service (drinking) water is produced. The Site drinking water well field is located near the eastern boundary of the Site within the Creek's floodplain. The Kesselring Site obtains all water for its operation from on-site production wells that are hydrogeologically separate from current and historical operational areas.

The Kesselring Site is located in the transition zone between the Adirondack Mountains and the Hudson-Mohawk Valley lowland. The Kayaderosseras Creek forms the main drainage system in the vicinity of the Site. The average flow in the Kayaderosseras Creek is 138 cubic feet per second (cfs) and the minimum recorded seven-day average flow for a 10-year period is 17 cfs.

The Glowegee Creek, Crook Brook, and Hogback Brook drain the Site. Crook Brook directly joins the Kayaderosseras. Hogback Brook is a tributary to the Glowegee, which is the receiving water for Site drainage. The average flow in the Glowegee is 38.3 cfs and the minimum recorded seven-day average flow for a 10 year period is 0.92 cfs. The Glowegee Creek joins with the Kayaderosseras Creek approximately one mile east of West Milton.

The Glowegee and Kayaderosseras Creeks are classified under New York State Codes, Rules and Regulations as Class C - Trout Streams. Under this classification the waters are suitable for fishing and fish propagation. Additionally, the water quality shall be suitable for primary and secondary contact recreation, even though other factors may limit the use for that purpose. The New York State Department of Environmental Conservation (NYSDEC) has permitted the Site to discharge effluent from various Site operations to the Glowegee Creek as specified in the Site’s State Pollutant Discharge Elimination System (SPDES) Permit (Reference (19)). Environmental monitoring has shown no measurable water quality degradation in the Glowegee Creek due to Site operations.

## 5.2 LIQUID EFFLUENT MONITORING

### 5.2.1 Sources

**Nonradiological:** The primary sources of the effluent water at the Kesselring Site are:

1. *Site Boiler House Discharges* - Site boiler water is treated demineralized water. Operations that result in releases are (1) annual boiler draining and periodic blowdowns to control the concentration of solids, and (2) wastewater from a reverse osmosis water treatment system.

2. *Sewage Treatment Plant* - The plant is a tertiary treatment facility employing an extended aeration/contact stabilization activated sludge process and chemical precipitation of phosphorous followed by sand filtration. Waste sludge is stored in a holding tank and is periodically removed by a licensed subcontractor for disposal at a State-approved facility.

3. *Cooling Tower Water* - Cooling tower water is treated to minimize scale formation, to prevent corrosion of system materials, and to inhibit the growth of algae and slime. The pH is normally maintained in the range of 7.1 to 8.2.

4. *Retention Basin Liquids* - The retention basins receive wastewater from prototype plant facilities including blowdown water from steam generators and drainage water from the engine rooms.

5. *Site Drainage Water* - Stormwater and groundwater (treated and untreated) also make up a portion of the liquid effluent. A portion of the groundwater on site is treated with sodium hypochlorite due to elevated levels of ammonia in the groundwater.

6. *Site Service Water* - Site service water is used for drinking water and non-contact cooling purposes. Sodium hypochlorite is added to the Site service water system as a drinking water disinfectant.

With the exception of the sewage treatment plant effluent and some stormwater, all of the above sources of effluent water are discharged into the Kesselring Site Lagoon and through a wastewater treatment system before ultimate off-site discharge into the Glowegee Creek. The Site lagoon is a five million gallon holding basin that was designed to accumulate effluent water for the purposes of pH control, thermal equalization, chlorine dissipation, and settling of solid particles.

**Radiological:** Some of the liquid effluent discharged from the retention basins contains low levels of radioactivity. The source of this radioactivity is small quantities of activation products. The activation products may include tritium and radionuclides of corrosion and wear products.

Tritium is present in the reactor coolant as the result of neutron interaction with naturally occurring deuterium present in the water. Tritium produced in the reactor exists in the oxide form and is chemically indistinguishable from water. Corrosion and wear products, in the form of small insoluble metal oxide particles, become radioactive as they pass through the reactor, with cobalt-60 being the predominant radionuclide. Operation of the prototype plant requires processing reactor coolant using radioactive liquid waste collection systems.

To minimize releases of radioactivity in liquid effluent to the environment, a water reuse system and evaporators are employed. The reactor coolant water that is discharged from the prototype plant to the radioactive liquid waste collection system is processed through a series of filters and demineralizers. The processing system removes nearly all of the radioactivity with the exception of tritium. After purification, the water is either reused as reactor coolant makeup and in other radioactive systems or evaporated, thereby reducing the amount of radioactivity that could be released as liquid effluent.

The low concentrations of radioactivity in the liquids released from the Kesselring Site have always been below all applicable Federal and State limits and have not resulted in any detectable radioactivity in the Glowegee Creek from Site operations.

### 5.2.2 Effluent Monitoring

**Nonradiological:** Liquid effluents from the Kesselring Site enter the Glowegee Creek through two surface channels (Outfalls 001 and 002) and a submerged drain line from the sewage treatment plant (Outfall 003) shown in Figure 5-1. A series of gates are located in the main discharge channel upstream of the lagoon to provide a means to contain effluent if concentrations should ever exceed applicable discharge limits. An internal outfall (Outfall 02B) discharges treated groundwater to the main discharge channel upstream of the lagoon.

Since 1998, the Kesselring Site has operated a wastewater treatment system at the outlet of the lagoon. This treatment system is designed primarily to minimize total suspended solids levels that result from algae blooms. This is necessary in order to maintain Site operations and to ensure continued compliance with the SPDES Permit requirements. The system also removes residual chlorine from the lagoon effluent using an automated sodium bisulfite system. Treatment is also provided for pH and temperature.

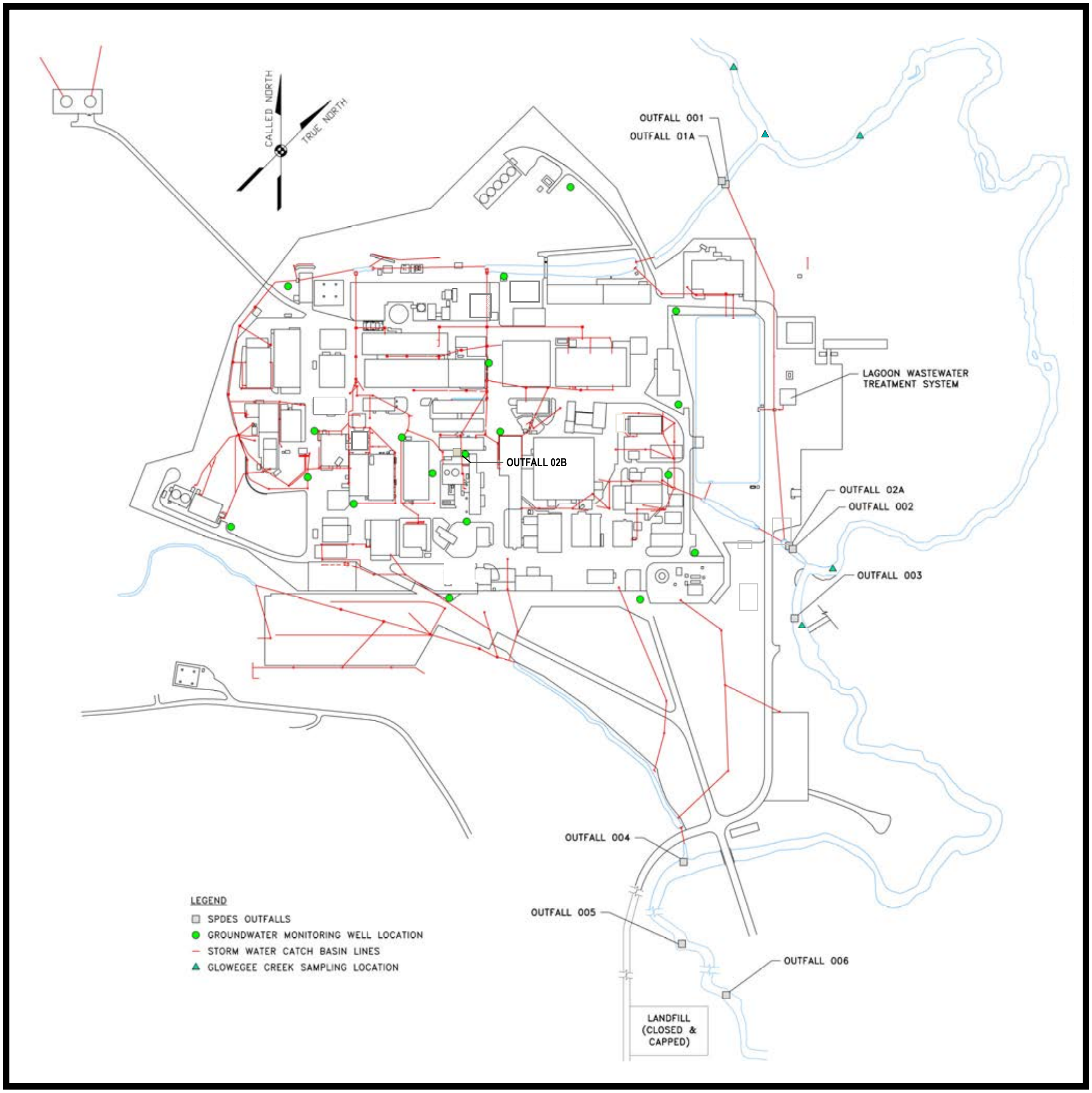


**Figure 5-1**
**Kesselring Site, Near West Milton, New York**
**Glowegee Creek Sampling Locations and Outfall Locations**

Effluent samples from the lagoon wastewater treatment system (Outfalls 001 and 002) and the sewage treatment plant (Outfall 003) are collected and analyzed as required by the SPDES Permit.

Stormwater from the Kesselring Site enters the Glowegee Creek from stormwater Outfalls 01A, 02A, 004, 005, and 006 (Figure 5-1). Outfalls 01A and 02A were used for Site discharge prior to the construction of the lagoon. These outfalls currently collect only stormwater.

Outfall 004, which discharges into the Glowegee Creek just below the main access road bridge, collects drainage from the parking lot and the southern part of the Site. Discharges through this outfall are controlled locally or remotely by a sluice gate. This gate provides control for contaminants (i.e., oils and chemicals) which could reach this drainage way in the event of a spill, fire, or other emergency. Stormwater also collects in Outfall 005 from Hogback Road and enters the Glowegee Creek. Outfall 006 collects stormwater runoff from the landfill that was closed and capped in 1993. Currently, no routine sampling or monitoring is required for stormwater Outfalls 01A, 02A, 004, 005, and 006.

In June 2007, NYSDEC's Stream Biomonitoring Unit performed an assessment of the Glowegee Creek. The report was published April 17, 2009, and a copy has been provided in the Saratoga Library. The results and conclusions were that the water quality in Glowegee Creek was very good at all locations, and there appeared to be no impacts from the Kesselring Site discharges.

**Radiological:** Liquid discharges that might contain tritium are either sampled and analyzed individually or sampled and combined into a monthly composite that is then analyzed for tritium. Monthly grab samples are also taken at Outfalls 001 and 002.

### 5.2.3 Effluent Analyses

**Nonradiological:** The analyses performed for chemical constituents on effluent samples from each discharge point and the sewage treatment plant are listed in Tables 5-1, 5-2, and 5-3. Analyses for chemical constituents are performed using procedures described in Standard Methods, Reference (8), or other EPA approved procedures. Flow, temperature, and total residual chlorine are measured at Outfalls 001 and 002 during every day on which there is a discharge from the lagoon, except when the flume is flooded with Glowegee Creek water. Outfall 001 is flooded more often than Outfall 002 because its elevation is lower.

**Radiological:** Each liquid discharge that might contain tritium is sampled. The samples are combined into a monthly composite for each frequently used release point. Samples from other tritium release points are analyzed individually. The monthly grab samples are analyzed for tritium and by gamma spectrometry. Tritium analyses are performed by liquid scintillation counting.

### 5.2.4 Assessment

**Nonradiological:** The analytical results for the measurements of chemical constituents summarized in Tables 5-1, 5-2, and 5-3 show that average values are within the applicable effluent standards. Liquid effluent monitoring data are reported as required in Reference (19).

**Radiological:** The radioactivity released in Kesselring Site liquid effluent during 2013 totaled 0.00178 curies of tritium as shown in Table 5-4. The activity was contained in approximately $5.58 \times 10^6$ liters of water. Tritium and gamma emitting radionuclides attributable to site operations were not detected in the monthly grab samples of the outfalls. The resulting annual average radioactivity concentration in the effluent corresponded to less than 0.1 percent of the DOE derived concentration guide for effluent released to unrestricted areas, (Reference (4)) for the mixture of radionuclides present. It is also less than 0.1 percent of the derived concentration standard of Reference (32) which became effective on September 1, 2013 with the renewal of the SPDES permit.

## TABLE 5-1 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE LIQUID EFFLUENT, OUTFALL 001, 2013

| | | Value | | | | |
|---|---|---|---|---|---|---|
| Parameter (units) | Number of Samples | Minimum(1) | Maximum(1) | Average(2) | SPDES Permit Limit | Percent of Limit (Using Average Value) |
| **Discharge Requirements (Reference 19)** | | | | | | |
| Flow (MGD)* | 357 | 0.00 | 1.09 | 0.19 | Monitor(3) | ---- |
| Temperature (Deg. F) | 159 | 34 | 74 | 54 | (Note 4) | ---- |
| Residual Chlorine (mg/L) | 159 | < 0.02 | < 0.02 | < 0.02 | 0.04 | < 50 |
| pH (SU)** | 12 | 7.5 | 8.9 | 7.9 | 6.0 - 9.0 | ---- |
| Oil and Grease (mg/L) | 12 | < 1.0 | < 1.0 | < 1.0 | 15 | < 7 |
| Total Suspended Solids (mg/L) | 12 | 1.5 | 16.5 | 8.8 | 45 | 20 |
| Nitrite as N (mg/L) | 12 | < 0.01 | 0.02 | < 0.01 | 0.04 | < 25 |
| Iron | | | | | | |
| (mg/L) | 12 | 0.136 | 0.447 | 0.234 | Monitor(3) | ---- |
| (lb/day) | 12 | 0.177 | 1.196 | 0.475 | (Note 5) | ---- |
| Total Phosphorus | | | | | | |
| (mg/L) | 12 | 0.08 | 0.16 | 0.12 | Monitor(3) | ---- |
| (kg/month) | 12 | 1.12 | 4.90 | 2.33 | (Note 6) | ---- |
| Zinc | | | | | | |
| (mg/L) | 12 | < 0.005 | 0.025 | < 0.014 | Monitor(3) | ---- |
| (lb/day) | 12 | 0.013 | 0.134 | < 0.030 | (Note 7) | ---- |
| Boron (mg/L) | 12 | < 0.050 | 0.070 | < 0.052 | 0.5 | < 10 |
| Sulfite (mg/L) | 12 | < 2.0 | < 2.0 | < 2.0 | 2.0 | < 100 |
| Nitrogen, Ammonia (as NH3) | 12 | < 0.1 | 0.4 | < 0.1 | Monitor(3) | ---- |
| **Additional Parameters Monitored (Not Required by Permit - Reference 19)** | | | | | | |
| Surfactants (MBAS) (mg/l) | 12 | < 0.02 | 0.02 | < 0.02 | N/A | N/A |

See Notes on Page 5-8

## TABLE 5-2 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE LIQUID EFFLUENT, OUTFALLS 002 AND 02B, 2013

| Parameter (units) | Number of Samples | Value: Minimum(1) | Value: Maximum(1) | Value: Average(2) | SPDES Permit Limit | Percent of Limit (Using Average Value) |
|---|---|---|---|---|---|---|
| **Discharge Requirements (Reference 19)** | | | | | | |
| Flow (MGD)* | 364 | 0.00 | 1.38 | 0.24 | Monitor(3) | ---- |
| Temperature (Deg. F) | 166 | 34 | 74 | 54 | (Note 4) | ---- |
| Residual Chlorine (mg/L) | 167 | < 0.02 | 0.13 | < 0.02 | 0.04 | < 50 |
| pH (SU)** | 12 | 7.6 | 8.9 | 7.9 | 6.0 - 9.0 | ---- |
| Oil and grease (mg/L) | 12 | < 1.0 | < 1.0 | < 1.0 | 15 | < 7 |
| Total Suspended Solids (mg/L) | 12 | 1.0 | 14.0 | 8.3 | 45 | 18 |
| Nitrite as N (mg/L) | 12 | < 0.01 | 0.02 | < 0.01 | 0.04 | < 25 |
| Iron | | | | | | |
| (mg/L) | 12 | < 0.107 | 0.436 | < 0.226 | Monitor(3) | ---- |
| (lb/day) | 12 | 0.207 | < 0.955 | < 0.536 | (Note 5) | ---- |
| Total Phosphorus | | | | | | |
| (mg/L) | 12 | 0.08 | 0.16 | 0.12 | Monitor(3) | ---- |
| (kg/month) | 12 | 1.22 | 7.96 | 3.33 | (Note 6) | ---- |
| Zinc | | | | | | |
| (mg/L) | 12 | < 0.005 | 0.024 | < 0.013 | Monitor(3) | ---- |
| (lb/day) | 12 | < 0.013 | < 0.107 | < 0.031 | (Note 7) | ---- |
| Boron (mg/L) | 12 | < 0.050 | 0.056 | < 0.051 | 0.5 | < 10 |
| Sulfite (mg/L) | 12 | < 2.0 | < 2.0 | < 2.0 | 2.0 | < 100 |
| Nitrogen, Ammonia (as NH3) | 12 | < 0.1 | 0.4 | < 0.1 | Monitor(3) | ---- |
| **Additional Parameters Monitored (Not Required by Permit - Reference 19)** | | | | | | |
| Surfactants (MBAS) (mg/L) | 12 | < 0.02 | < 0.02 | < 0.02 | N/A | N/A |
| **OUTFALL 02B** | | | | | | |
| Residual Chlorine (mg/L) | 12 | 5.9 | 14.7 | 8.8 | Monitor(3) | ---- |
| Nitrite as N (mg/L) | 12 | < 0.01 | < 0.01 | < 0.01 | Monitor(3) | ---- |
| Nitrogen, Ammonia (as NH3) | 12 | < 0.1 | < 0.1 | < 0.1 | 2.0 | < 5 |

See Notes on Page 5-8

## NOTES FOR TABLES 5-1 AND 5-2

(1) A value preceded by "<" is less than the practical quantitation limit for that sample and parameter.

(2) Average values preceded by "<" contain at least one less than practical quantitation limit value in the average.

(3) The Reference 19 permit requires the data to be reported but does not specify a limit for this discharge parameter.

(4) During the period from May through October, the temperature of heated water discharges from Site operations shall not exceed 75 $^oF$, except that if the ambient stream temperature exceeds 75 $^oF$, the temperature of the discharge can be equal to the stream temperature, up to a maximum of 78 $^oF$. During the period from November through April, the temperature of the heated water discharges from Site operations shall not exceed 75 $^oF$. In addition, no discharges will occur which will raise the temperature of the stream by more than 5 $^oF$, or to a maximum of 55 $^oF$, whichever temperature is less, except that if the upstream temperature is > 55 $^oF$, the discharge to the stream shall be such that the downstream temperature is less than or equal to the upstream temperature.

(5) Total Site mass discharge limit of 4.0 lbs/day for Outfalls 001, 002, and 003 combined.

(6) An action level of 50 kg/month has been assigned for the total mass discharged from Outfalls 001, 002, and 003 combined. An action level is not a limit, but a specified effluent level that requires additional short term monitoring upon exceedance.

(7) Total Site mass discharge limit of 0.5 lbs/day for Outfalls 001, 002, and 003 combined.

* MGD = Million Gallons per Day
** SU = Standard Units
N/A = Not Applicable

## TABLE 5-3 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE SEWAGE TREATMENT PLANT EFFLUENT, OUTFALL 003, 2013

| Parameter (units) | Number of Samples | Value: Minimum(1) | Value: Maximum(1) | Value: Average(2) | SPDES Permit Limit | Percent of Limit (Using Average Value) |
|---|---|---|---|---|---|---|
| **Discharge Requirements (Ref. 19)** | | | | | | |
| Flow (MGD)* | 346 | 0.004 | 0.025 | 0.012 | 0.09(3) | 13 |
| pH (SU)** | 240 | 7.1 | 8.2 | 7.7 | 6.0 - 9.0 | ---- |
| Settleable Solids (ml/L) | 240 | < 0.1 | < 0.1 | < 0.1 | 0.1 | < 100 |
| Dissolved Oxygen (mg/L) | 240 | 6.4 | 14.6 | 9.1 | ≥ 5.0 | (Note 4) |
| Nitrite-N (mg/L) | 12 | < 0.01 | 0.50 | < 0.09 | 0.6 | < 15 |
| Cyanide, Available (mg/L) | 12 | < 0.002 | < 0.002 | < 0.002 | 0.09 | < 2 |
| Ammonia-N (mg/L) | 12 | < 0.1 | 1.0 | < 0.3 | 25 | < 1 |
| Surfactants (MBAS) (mg/L) | 12 | < 0.02 | 0.07 | < 0.04 | 0.7 | < 6 |
| Boron (mg/L) | 12 | < 0.050 | < 0.050 | < 0.050 | 1.2(5) | < 4 |
| Dissolved Copper (mg/L) | 12 | < 0.005 | 0.014 | < 0.008 | Monitor(6) | ---- |
| Biological Oxygen Demand-5 (mg/L) | 12 | < 4 | < 5 | < 4 | 30(7) | < 13 |
| Total Suspended Solids (mg/L) | 12 | < 1.0 | 2.0 | < 1.1 | 30(7) | < 4 |
| Total Phosphorus | | | | | | |
| (mg/L) | 12 | 0.12 | 2.84 | 1.84 | Monitor(6) | ---- |
| (kg/month) | 12 | 0.05 | 4.68 | 2.73 | (Note 8) | ---- |
| Zinc | | | | | | |
| (mg/L) | 12 | 0.011 | 0.074 | 0.025 | Monitor(6) | ---- |
| (lbs/day) | 12 | 0.001 | 0.008 | 0.003 | (Note 9) | ---- |
| Total Copper (lbs/day) | 12 | 0.0003 | 0.0017 | < 0.0010 | 0.06 | < 2 |
| Iron | | | | | | |
| (mg/L) | 12 | < 0.050 | 0.143 | < 0.061 | Monitor(6) | ---- |
| (lbs/day) | 12 | < 0.003 | 0.016 | < 0.008 | (Note 10) | ---- |
| Aluminum (mg/L) | 12 | < 0.100 | 0.107 | < 0.101 | 2.0(5) | < 5 |
| Butyl Benzyl Phthalate (mg/L) | 12 | < 0.0050 | < 0.0052 | < 0.0050 | 0.1(5) | < 5 |
| **Additional Parameters Monitored (Not Required by Permit - Reference 19)** | | | | | | |
| Temperature (Deg. F) | 240 | 40 | 77 | 58 | N/A | N/A |

Notes:
(1) A value preceded by “<” is less than the practical quantitation limit for that sample and parameter.
(2) Average values preceded by “<” contain at least one less than practical quantitation limit value in the average.
(3) 30-day average.
(4) The average value is well above the limit, which is a minimum value.
(5) Values are action levels which are not a limit but a specified effluent level which requires additional short term monitoring upon exceedance.
(6) The Reference 19 permit requires the data to be reported but does not specify a limit for this discharge parameter.
(7) The maximum limit for the 30-day arithmetic mean is 30 mg/l; the maximum limit for the 7-day arithmetic mean is 45 mg/l.
(8) An action level of 50 kg/month has been assigned for the total mass discharged from Outfalls 001, 002 and 003 combined. An action level is not a limit but a specified effluent level that requires additional short term monitoring upon exceedance.
(9) Total Site mass discharge limit of 0.5 lbs/day for Outfalls 001, 002, and 003 combined.
(10) Total Site mass discharge limit of 4.0 lbs/day for Outfalls 001, 002, and 003 combined.
* MGD = Million Gallons per Day
** SU = Standard Units
N/A = Not Applicable

**TABLE 5-4 KESSELRING SITE RADIOACTIVITY RELEASED IN LIQUID EFFLUENT, 2013**

| Radionuclide | Release Ci(1) | Half-life |
|---|---|---|
| H-3 | 1.78E-03 | 12.32 years |

Note: (1) The total includes results that were less than or equal to the decision level concentration.

## 5.3 AIRBORNE EFFLUENT MONITORING

### 5.3.1 Sources

**Nonradiological:** The principal sources of industrial gaseous effluents are two 21 million and one 31 million BTU/hr steam generating boilers. The Number 2 fuel oil that is used to fire all of the boilers contains less than 0.5 weight percent sulfur. Combustion gases from the boilers are released through two elevated exhaust stacks. Other operations such as carpenter shops, welding hoods, abrasive cleaning, and spray painting constitute point sources of airborne effluents.

**Radiological:** Small quantities of particulate radioactivity, principally cobalt-60, are processed through controlled exhaust systems during reactor coolant sampling, draining, and venting operations. Gaseous radioactivity contained in the exhaust air consists principally of carbon-14, short-lived isotopes of xenon and krypton, argon-41, and tritium. Carbon-14 and argon-41 are the result of neutron interaction with isotopes of dissolved oxygen, nitrogen, and argon in the coolant. Other radioactive gases such as xenon and krypton are produced by neutron interaction with trace quantities of uranium impurities in structural members within the reactor. Prior to release from the exhaust stacks, the exhaust air is passed through high efficiency particulate air (HEPA) filter systems to minimize particulate radioactivity content. Additionally, some processed water is evaporated to minimize releases of radioactivity in liquid effluent. The evaporator air effluent contains gaseous tritium. Potential diffuse sources are also evaluated and include emissions from D&D activities such as building demolition.

### 5.3.2. Effluent Monitoring

**Nonradiological:** Emissions of oxides of nitrogen ($NO_x$) from the Site's steam boilers are controlled by a NYSDEC Air Facility Registration that limits total fuel usage to no more than 1,250,000 gallons in any 12-month period. For the Site boilers, monthly usage records are tracked and tabulated to ensure registration compliance. Fuel oil supplier certification and applicable fuel oil analyses for distillate fuel oil are maintained to confirm that the fuel oil burned in Kesselring Site boilers contains less than 0.5 percent sulfur by weight and conforms to the ASTM Standards for distillate fuel oil. Semiannual reports demonstrating compliance with the fuel oil sulfur limitation are sent to the EPA as required by EPA's New Source Performance Standards (NSPS) for these size stationary combustion installations. All other industrial emission points at the Kesselring Site do not require permits due to very low emission levels.

**Radiological:** The air exhausted from the reactor plants is continuously monitored for particulate radioactivity with monitors that are equipped with alarm functions to provide an alert should an out-of-specification release occur. The air exhausted from all radiological work facilities is continuously sampled for particulate radioactivity. Reactor plant air emissions are also continuously sampled for radioiodine with activated charcoal cartridges. Sampling is performed for tritium and carbon-14 using appropriate absorbers.

## TABLE 5-5 KESSELRING SITE RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT, 2013

| Radionuclide | Point Source Release Ci(1) | Diffuse Source Release Ci | Total Release Ci | Half-life |
|---|---|---|---|---|
| H-3 | 8.63E-02 | 0.00E+00 | 8.63E-02 | 12.32 years |
| C-14 | 3.27E-02 | 5.39E-09 | 3.27E-02 | 5715 years |
| Co-60 | 3.22E-06 | 3.59E-07 | 3.58E-06 | 5.271 years |
| Kr-85 | 1.29E-06 | 0.00E+00 | 1.29E-06 | 10.76 years |
| Sr-90 | 0.00E+00 | 7.18E-11 | 7.18E-11 | 28.78 years |
| Ag-110m | 0.00E+00 | 2.15E-09 | 2.15E-09 | 249.85 days |
| Co-58 | 0.00E+00 | 6.82E-08 | 6.82E-08 | 70.80 days |
| Cs-134 | 0.00E+00 | 1.44E-10 | 1.44E-10 | 2.062 years |
| Cs-137 | 0.00E+00 | 1.44E-09 | 1.44E-09 | 30.07 years |
| Fe-55 | 0.00E+00 | 3.59E-07 | 3.59E-07 | 2.70 years |
| I-129 | 0.00E+00 | 7.18E-14 | 7.18E-14 | 1.57E07 years |
| I-131 | 4.80E-07 | 0.00E+00 | 4.80E-07 | 8.04 days |
| Mn-54 | 0.00E+00 | 2.87E-08 | 2.87E-08 | 312.7 days |
| Nb-94 | 0.00E+00 | 7.18E-11 | 7.18E-11 | 2.03E04 years |
| Ni-59 | 0.00E+00 | 2.87E-10 | 2.87E-10 | 7.50E04 years |
| Ni-63 | 0.00E+00 | 2.87E-08 | 2.87E-08 | 100.10 years |
| Sb-125 | 0.00E+00 | 1.80E-09 | 1.80E-09 | 2.77 years |
| Tc-99 | 0.00E+00 | 1.44E-10 | 1.44E-10 | 2.13E05 years |
| Zn-65 | 0.00E+00 | 2.87E-09 | 2.87E-09 | 244.40 days |
| Fission and Activation Products ($T_{1/2}$> 3hr) | 4.80E-07 | 4.94E-07 | 9.74E-07 | |
| Ar-41 | 4.58E-01 | 0.00E+00 | 4.58E-01 | 1.83 hours |
| Kr-83m | 4.73E-04 | 0.00E+00 | 4.73E-04 | 1.86 hours |
| Kr-85m | 1.10E-03 | 0.00E+00 | 1.10E-03 | 4.48 hours |
| Kr-87 | 1.36E-03 | 0.00E+00 | 1.36E-03 | 1.27 hours |
| Kr-88 | 2.37E-03 | 0.00E+00 | 2.37E-03 | 2.84 hours |
| Xe-131m | 8.54E-05 | 0.00E+00 | 8.54E-05 | 11.9 days |
| Xe-133m | 5.79E-04 | 0.00E+00 | 5.79E-04 | 2.19 days |
| Xe-133 | 1.60E-02 | 0.00E+00 | 1.60E-02 | 5.243 days |
| Xe-135 | 1.49E-02 | 0.00E+00 | 1.49E-02 | 9.10 hours |
| Noble Gases ($T_{1/2}$<40 days) | 4.95E-01 | 0.00E+00 | 4.95E-01 | |

Note: (1) The H-3, C-14, Co-60, and I-131 totals include results that were less than or equal to the decision level concentration.

### 5.3.3 Effluent Analyses

**Radiological:** The air particulate sample filters from the radiological emission points are changed routinely and analyzed by gamma spectrometry. A decision level concentration of approximately 5 x $10^{-15}$ µCi/ml is achieved for cobalt-60. The activated charcoal cartridges are analyzed for radioiodine by gamma spectrometry to a decision level concentration of approximately 5 x $10^{-15}$ µCi/ml for iodine-131. The tritium and carbon-14 absorbers are analyzed by liquid scintillation spectrometry. The decision level concentrations of tritium and carbon-14 in air are approximately 5 x $10^{-11}$ µCi/ml for typical sampling parameters. The quantity of gaseous radioactivity released is calculated based on reactor plant operating parameters.

### 5.3.4 Assessment

**Nonradiological:** Emissions of $NO_x$ continue to be well within the limits established by NYSDEC in the registration associated with the Site boiler units. Emissions of $SO_x$ from the Site boiler units are also well within the EPA's NSPS emission standards for stationary combustion installations.

All other point source emissions also conform to the applicable Federal and State clean air standards.

**Radiological:** The radioactivity released in airborne effluent during 2013 is shown in Table 5-5. The radioactivity was contained in a total volume of 5.83 x $10^{11}$ liters of air. The average radioactivity concentration in the effluent air was well below the applicable standards listed in Reference (4). The average annual radioactivity concentration at the nearest Site boundary, based on average annual diffusion parameters, was less than 0.01 percent of the DOE derived concentration guide for effluent release to unrestricted areas (Reference 4) for the mixture of radionuclides present. Diffuse source emissions are calculated using EPA approved methods. Airborne effluent monitoring data are reported as required in Reference (6).

## 5.4 ENVIRONMENTAL MONITORING

### 5.4.1 Scope

**Nonradiological:** The nonradiological environmental monitoring program at the Kesselring Site during 2013 included monitoring and recording of the Glowegee Creek temperature conducted upstream of the Site, between the discharge channels, and downstream of the Site discharge locations each day the site discharged water through Outfalls 001 and 002. Flow measuring equipment is installed in the Site's three non-stormwater discharge channels. In addition, Glowegee Creek flow is monitored by the U.S. Geological Survey (USGS) one-half mile downstream of the Site at the West Milton Road gauging station (USGS No. 01330000).

A voluntary aquatic life sampling and evaluation program is conducted in the Glowegee Creek upstream, near the discharge channels, and downstream in the Glowegee Creek. Backpack electro-fishing techniques are used to collect the fish, which are identified, measured, and returned to the creek unharmed.

The Kesselring Site operated its own sanitary landfill for the disposal of non-radioactive and non-hazardous solid wastes until October 1993, when landfill operations permanently ceased. NYSDEC approved the final Landfill Closure Plan, and landfill closure construction was completed in October 1994. The closed landfill is maintained in accordance with a Post Closure

Monitoring and Maintenance Operations Manual, which has been approved by NYSDEC. Groundwater monitoring of the landfill is performed in accordance with this manual (refer to Section 5.6).

**Radiological:** The radiological environmental monitoring program at the Kesselring Site during 2013 included: (1) the collection of fish upstream and downstream of discharge locations to the Glowegee Creek, (2) the collection of quarterly samples of Glowegee Creek water and sediment at five locations, (3) the operation of continuous air samplers at stations located in the primary upwind and downwind directions from the Site.

Three samples of sediment and one composite water sample are collected quarterly for radioanalysis across the creek at the five locations shown in Figure 5-1.

Environmental air samplers are operated in the primary upwind and downwind directions from the Site to measure normal background airborne radioactivity and to confirm that Kesselring Site effluents have no measurable effect on normal background levels.

### 5.4.2 Analyses

**Radiological:** The routine quarterly samples of Glowegee Creek water and bottom sediment samples are analyzed with a high-purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analyses is performed annually on the fish and some of the water and sediment samples collected from the Glowegee Creek. The more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides. The environmental air particulate sample filters are changed and analyzed routinely by high-purity germanium gamma spectrum analysis.

### 5.4.3 Assessment

**Nonradiological:** The Glowegee Creek fish survey results from 2013 are summarized in Table 5-6. The concentrations of chemical constituents in liquid effluent from the Kesselring Site resulted in no adverse effect on the quality of the Glowegee Creek. This conclusion is substantiated by results of the fish surveys that confirmed the existence of a diverse and healthy aquatic community in the creek water. The 2013 survey data are consistent with historical fish survey data. The different relative abundance of fish species at each sampling location reflects their different preferred habitats.

**Radiological:** The gamma spectrum analysis results for fish collected from the Glowegee Creek are shown in Table 5-7. The results show no radioactivity attributable to Site operations. The only radionuclide observed in both fish samples was potassium-40. This naturally occurring radionuclide is frequently observed in fish.

Results of the gamma analysis of sediment and water samples are shown in Table 5-8. The data show that there is no significant difference between radioactivity concentrations measured upstream and downstream. Only naturally occurring radionuclides were detected in the Glowegee Creek water samples. Results of the detailed gamma spectrum analyses performed on sediment samples also indicate low concentrations of potassium-40, cesium-137, and daughters of uranium and thorium. Potassium-40 and the daughters of uranium and thorium are naturally occurring radionuclides and are not associated with Site operations. The EPA has attributed similar low levels of cesium-137 to fallout from low yield atmospheric nuclear weapon tests. Since the beginning of prototype operations more than 50 years ago, the release of radioactivity into the Glowegee Creek has been small and has had no adverse effect on the natural background radioactivity levels in the sediment.

The results for the environmental air samples show that there was no significant difference between the average upwind and downwind radioactivity concentrations. The average upwind radioactivity concentration was $3.13 \times 10^{-15}$ µCi/ml and the average downwind radioactivity concentration was $4.91 \times 10^{-15}$ µCi/ml. Gamma spectrum analyses indicated the presence of only background quantities of naturally occurring radionuclides.

## 5.5 RADIATION MONITORING

The purpose of the environmental radiation monitoring program is to measure the ambient radiation levels around the Site to confirm that operations have not altered the natural radiation background levels at the Site perimeter. The sources of radiation at the Site are the operation and maintenance of the prototype reactor plants.

### 5.5.1 Scope

Environmental radiation levels were monitored at the perimeter of the Site with a network of DT-702/PD lithium fluoride thermoluminescent dosimeters (TLDs). The eight locations of the Site perimeter TLDs are shown in Figure 5-2. Control TLDs were posted at four remote off-site locations to measure the natural background levels typical of the surrounding area. All TLDs were posted for quarterly exposure periods.

### 5.5.2 Analyses

The DT-702/PD lithium-fluoride environmental TLDs are calibrated to a cesium-137 standard source. The TLD radiation exposures were measured quarterly utilizing an automated TLD readout system that was calibrated prior to the processing of the TLDs.

### 5.5.3 Assessment

The total annual radiation exposures measured with TLDs at the boundary of the Kesselring Site and at remote, off-site monitoring locations are summarized in Table 5-9. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that Kesselring Site operations in 2013 had no measurable effect on natural background radiation levels at the Site perimeter.

## TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 2013

| Location | Species | Number Collected | Length (mm) |
|---|---|---|---|
| 400 Feet Upstream of 001 | Blacknose Dace | 27 | 37-69 |
| | Bluegill | - | - |
| U-2 | Bluntnose Minnow | - | - |
| | Brook Stickleback | 2 | 38-45 |
| | Brook Trout | - | - |
| | Brown Bullhead | - | - |
| | Brown Trout | - | - |
| | Common Shiner | 10 | 61-78 |
| | Creek Chub | 87 | 54-143 |
| | Cutlips Minnow | 24 | 47-108 |
| | Fallfish | - | - |
| | Fathead Minnow | - | - |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | 5 | 61-78 |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 11 | 52-68 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 5 | 51-71 |
| | White Sucker | 6 | 58-199 |
| | Yellow Bullhead | 3 | 118-151 |
| | Yellow Perch | - | - |
| 50 Feet Upstream of 001 | Blacknose Dace | 135 | 40-67 |
| | Bluegill | - | - |
| U-1 | Bluntnose Minnow | 3 | - |
| | Brook Stickleback | - | - |
| | Brook Trout | - | - |
| | Brown Bullhead | - | - |
| | Brown Trout | - | - |
| | Common Shiner | 4 | 59-81 |
| | Creek Chub | 85 | 41-118 |
| | Cutlips Minnow | 15 | 38-106 |
| | Fallfish | - | - |
| | Fathead Minnow | 5 | 49-57 |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | 8 | 44-79 |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 9 | 54-72 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 10 | 53-68 |
| | White Sucker | 3 | 48-61 |
| | Yellow Bullhead | 2 | 91-140 |
| | Yellow Perch | - | - |
| 360 Feet Downstream of 001 | Blacknose Dace | 84 | 31-69 |
| | Bluegill | - | - |
| M-1 | Bluntnose Minnow | 5 | 67-71 |
| | Brook Stickleback | 1 | 41 |
| | Brook Trout | - | - |
| | Brown Bullhead | - | - |
| | Brown Trout | - | - |
| | Common Shiner | 23 | 60-79 |
| | Creek Chub | 45 | 36-136 |
| | Cutlips Minnow | 35 | 52-116 |
| | Fallfish | 1 | 104 |
| | Fathead Minnow | - | - |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | - | - |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 5 | 48-63 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 9 | 56-65 |
| | White Sucker | 2 | 44-98 |
| | Yellow Bullhead | 4 | 108-141 |
| | Yellow Perch | - | - |

## TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 2013 (Continued)

| Location | Species | Number Collected | Length (mm) |
|---|---|---|---|
| 2350 Feet Downstream of 001 | Blacknose Dace | 46 | 43-64 |
| | Bluegill | - | - |
| D-2 | Bluntnose Minnow | 19 | 45-73 |
| | Brook Stickleback | 1 | 38 |
| | Brook Trout | - | - |
| | Brown Bullhead | 1 | 114 |
| | Brown Trout | - | - |
| | Common Shiner | 4 | 65-85 |
| | Creek Chub | 67 | 38-104 |
| | Cutlips Minnow | 11 | 56-112 |
| | Fallfish | 1 | 81 |
| | Fathead Minnow | - | - |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | - | - |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 1 | 78 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 3 | 55-63 |
| | White Sucker | 15 | 50-143 |
| | Yellow Bullhead | 1 | 154 |
| | Yellow Perch | - | - |
| 2700 Feet Downstream of 001 | Blacknose Dace | 46 | 38-60 |
| | Bluegill | - | - |
| D-1 | Bluntnose Minnow | 22 | 54-68 |
| | Brook Stickleback | 1 | 37 |
| | Brook Trout | - | - |
| | Brown Bullhead | - | - |
| | Brown Trout | - | - |
| | Common Shiner | 10 | 49-78 |
| | Creek Chub | 60 | 42-109 |
| | Cutlips Minnow | 5 | 58-86 |
| | Fallfish | - | - |
| | Fathead Minnow | - | - |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | 3 | 61-88 |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 2 | 58-67 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 5 | 59-63 |
| | White Sucker | 2 | 63-108 |
| | Yellow Bullhead | - | - |
| | Yellow Perch | - | - |
| 5000 Feet Downstream of 001 | Blacknose Dace | 70 | 48-72 |
| | Bluegill | - | - |
| D-3 | Bluntnose Minnow | - | - |
| | Brook Stickleback | - | - |
| | Brook Trout | - | - |
| | Brown Bullhead | - | - |
| | Brown Trout | - | - |
| | Common Shiner | 8 | 71-88 |
| | Creek Chub | 28 | 60-112 |
| | Cutlips Minnow | 18 | 58-114 |
| | Fallfish | - | - |
| | Fathead Minnow | - | - |
| | Golden Shiner | - | - |
| | Largemouth Bass | - | - |
| | Longnose Dace | 11 | 68-92 |
| | Northern Redbelly Dace | - | - |
| | Pearl Dace | - | - |
| | Pumpkinseed | 4 | 53-61 |
| | Rainbow Trout | - | - |
| | Tessellated Darter | 2 | 68-72 |
| | White Sucker | 2 | 92-94 |
| | Yellow Bullhead | - | - |
| | Yellow Perch | - | - |

## TABLE 5-7 RESULTS OF ANALYSES OF GLOWEGEE CREEK FISH FOR RADIOACTIVITY, 2013

| Sample Location | Radioactivity Concentration[1] (pCi/g wet wt) K-40 | Cs-137 | Co-60 |
|---|---|---|---|
| Upstream of Discharge Channel 001 | 2.985 ± 0.313 | <0.008 | <0.009 |
| Downstream of Discharge Channel 002 | 3.106 ± 0.315 | <0.008 | <0.008 |

Note: (1) A value preceded by "<" is less than the decision level concentration for that sample parameter. The (±) value represents the statistical uncertainty at two standard deviations.

## TABLE 5-8 RESULTS OF ANALYSES OF GLOWEGEE CREEK SEDIMENT AND WATER FOR RADIOACTIVITY, 2013

| | No. of Samples | Cobalt-60 Radioactivity Concentration | | | | | |
|---|---|---|---|---|---|---|---|
| | | Sediment (pCi/gm, dry wt)[1, 2] | | | Water (pCi/l)[2] | | |
| Sample Location | Sediment/Water | Minimum | Maximum | Average | Minimum | Maximum | Average |
| Upstream of Discharge Channel 001 | 12/4 | < 0.01 | < 0.02 | < 0.01 | <8.91 | <13.67 | <11.09 |
| Opposite Discharge Channel 001 | 12/4 | < 0.01 | < 0.02 | < 0.02 | <7.76 | <10.81 | <9.55 |
| Between Discharge Channels 001 & 002 | 12/4 | < 0.01 | < 0.02 | < 0.01 | <9.23 | <12.32 | <10.75 |
| Opposite Discharge Channel 002 | 12/4 | < 0.01 | < 0.02 | < 0.01 | <5.48 | <10.74 | <9.11 |
| Downstream of Discharge Channel 003 | 12/4 | < 0.01 | < 0.02 | < 0.01 | <8.62 | <11.57 | <10.23 |

Notes: (1) Dry weight is based on sample weight with free water removed.
(2) A value preceded by "<" is less than the decision level concentration for that sample and parameter.

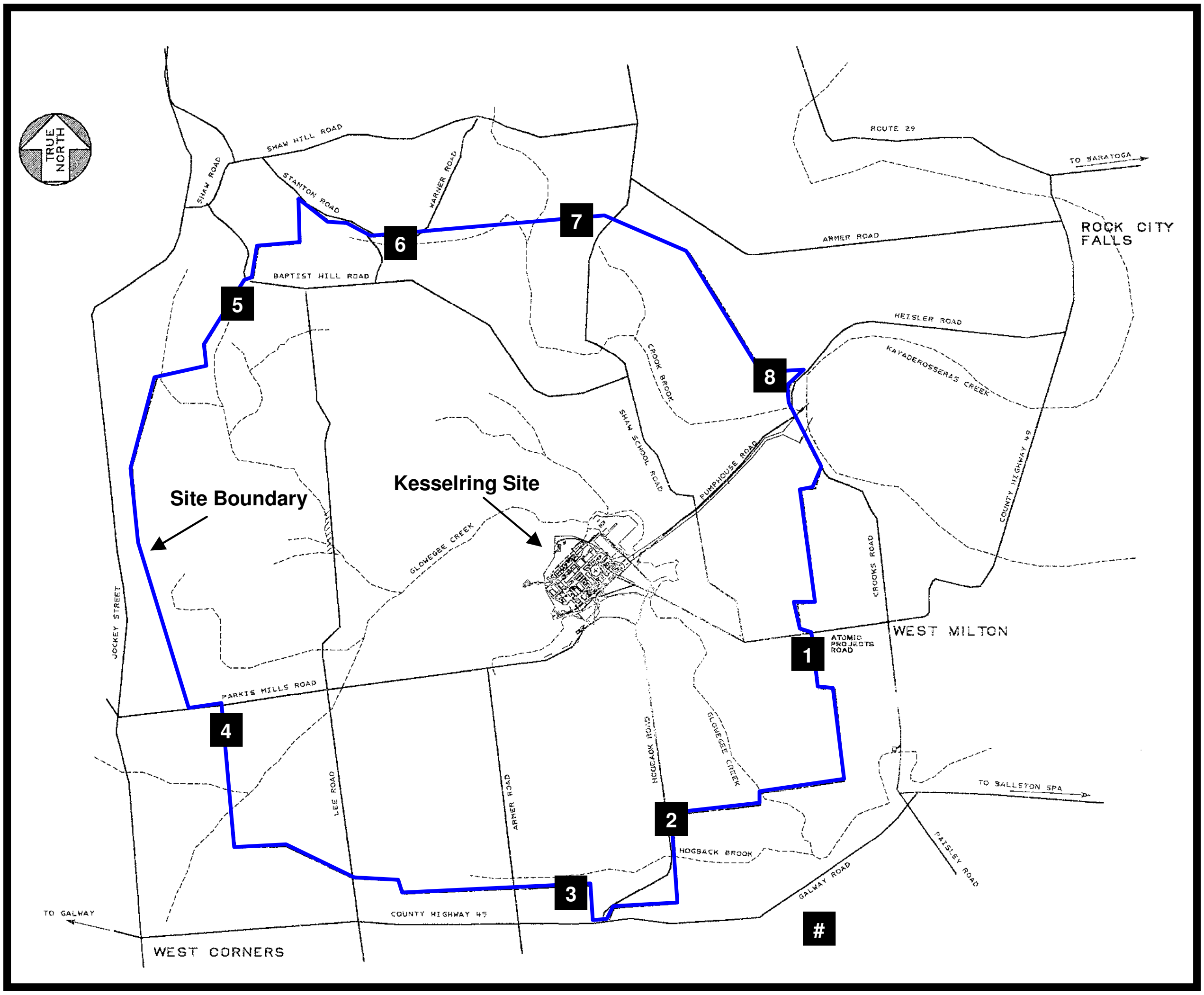


**Figure 5-2**
**Kesselring Site, Near West Milton, New York**
**Perimeter Monitoring Locations**

**TABLE 5-9 PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KESSELRING SITE, 2013**

| Perimeter Location No.[1] | Total Annual Exposure (millirem)[2] |
|---|---|
| 1 | 61 ± 1 |
| 2 | 51 ± 3 |
| 3 | 54 ± 6 |
| 4 | 53 ± 2 |
| 5 | 57 ± 3 |
| 6 | 54 ± 1 |
| 7 | 58 ± 4 |
| 8 | 56 ± 1 |
| Off-site locations | 61 ± 19 [3] |

Notes:
(1) See Figure 5-2 for monitoring locations.
(2) The (±) values for individual locations are expressed at the 2 sigma confidence level based on the calculated measurement uncertainty.
(3) Approximately 95% of natural background radiation measurements are expected to be within this range.

## 5.6 GROUNDWATER MONITORING

### 5.6.1 Scope

The Kesselring Site groundwater program includes environmental (nonradiological) monitoring of the closed Hogback Road Landfill in accordance with NYSDEC regulations and the voluntary monitoring of wells within the developed area of the Site. Voluntary radiological monitoring of groundwater is also performed concurrently at the above locations, and at several outlying areas of the Site. The groundwater monitoring program is summarized in Table 5-10.

In 1993, the Hogback Road Landfill was closed, and in 1994 it was capped in accordance with NYSDEC guidance and the required NYSDEC reviews and approvals. Landfill capping minimizes the amount of precipitation moving through the fill material and serves to stabilize and lessen the generation of landfill leachate that would migrate into groundwater. The Hogback Road Landfill Post-Closure Monitoring and Maintenance Operations Manual documents all of the required measures KAPL takes to ensure the integrity of the landfill cap, and any associated impacts to the environment are tracked and understood.

The Landfill regulatory-required monitoring program consists of annually sampling six groundwater monitoring wells during the late summer to fall timeframe when groundwater tables are typically lowest. Five shallow overburden wells (HB-1A, LMW-4, HB-5A2, LMW-6, and HB-11A) and one deep bedrock well (HB-5B) are sampled for a focused list of analytical parameters approved by NYSDEC. The locations of all existing landfill groundwater monitoring wells are shown in Figure 5-3. In addition to annual groundwater monitoring, KAPL performs quarterly inspections of landfill integrity and an annual survey for explosive gases at the landfill gas vents.

The groundwater monitoring program for the developed area (Figure 5-4) typically consists of annual sampling of 19 monitoring wells. This sampling is performed as a best management practice to track known constituents and to provide early detection of unexpected releases. Sections 5.6.3 and 5.6.4 provide an assessment of the 2013 monitoring events.

The groundwater monitoring program for the former disposal areas consists of annual sampling of 13 monitoring wells in four separate areas (Figure 5-5) for radiological analyses. In 1999, KAPL evaluated each of the former disposal sites with regard to the nature of the disposal source material, hydrogeology, and historic analytical database, and concluded that no groundwater threat exists. These wells are monitored to maintain a record of negative radiological data.

### 5.6.2 Sources

**Nonradiological:** Elevated parameters in the landfill wells are associated with past disposal practices. The landfill, operated since 1951 and closed in 1993, was used predominantly for the disposal of sanitary wastes. Prior to enactment of Federal and State regulations for solid waste disposal activities that banned disposal of certain wastes in such facilities, asbestos scraps, scrap metal including lead, some oil and oily water, solvents, paint, and chemicals were disposed of in the landfill.

Elevated parameters in and adjacent to the developed area of the Kesselring Site are predominantly the result of operational activities: historical material handling practices and construction activities, on-going use of roadway de-icing materials (i.e., sodium chloride, calcium chloride), cooling tower operations, and routine operations of Site service water systems containing chlorine. In 2007, elevated ammonia levels were detected in groundwater collected from drainage system underlying the newly constructed Building 102. Investigation of the elevated ammonia levels indicated that leaking sanitary sewage lines were a contributing source. These sewage lines have since been fixed.

The five former disposal sites at the Kesselring Site were used for construction and demolition waste, limited amounts of acid waste, and some waste burning. These disposal practices were conducted prior to enactment of Federal and State regulations governing the disposal of these materials.

### 5.6.3 Analyses

**Nonradiological:** All groundwater samples are analyzed by a New York State Department of Health certified laboratory for chemical parameters in accordance with Reference (8) or other EPA approved methods. Field parameters, which include static water level, temperature, and pH, are measured on site at the time of environmental sampling. Specific conductance and turbidity are sampled on site at the time of sampling for some monitoring events and are analyzed at a certified laboratory for others. The sample results are discussed in Section 5.6.4.

## TABLE 5-10 KESSELRING SITE GROUNDWATER MONITORING PROGRAM, 2013

| Program Area | Monitoring Wells | Field Parameters & Modified Routine List & Halogenated Volatile Organic Compounds[1,2] | Field Parameters & Volatile Organic Compounds | Radio-activity |
|---|---|---|---|---|
| Landfill | HB-1A, HB-5A2, HB-5B, HB-11A, LMW-4, LMW-6 | A, R | | A, V |
| Developed Area | MW-1 to MW-20[3] | | A, V[4] | A, V |
| Land Disposal Areas | KBH-1 to KBH-4, KBH-6 to KBH-13, and T-3 | | | A, V |

Notes: A = Annual, R= Regulatory Required Monitoring, V = Voluntary Monitoring

(1) See section 5.6.3 for a listing of parameters.

(2) Filtered metals analysis is performed as necessary for verification of elevated metals which are attributable to sample turbidity (suspended clay/silt particles).

(3) Except MW-5, which has been decommissioned.

(4) In 2007, the scope of the developed area well sampling was expanded to include additional sampling events and additional parameters (chemical and metal) in support of investigation activities related to elevated ammonia levels detected in developed area groundwater. These results are not published in this report.

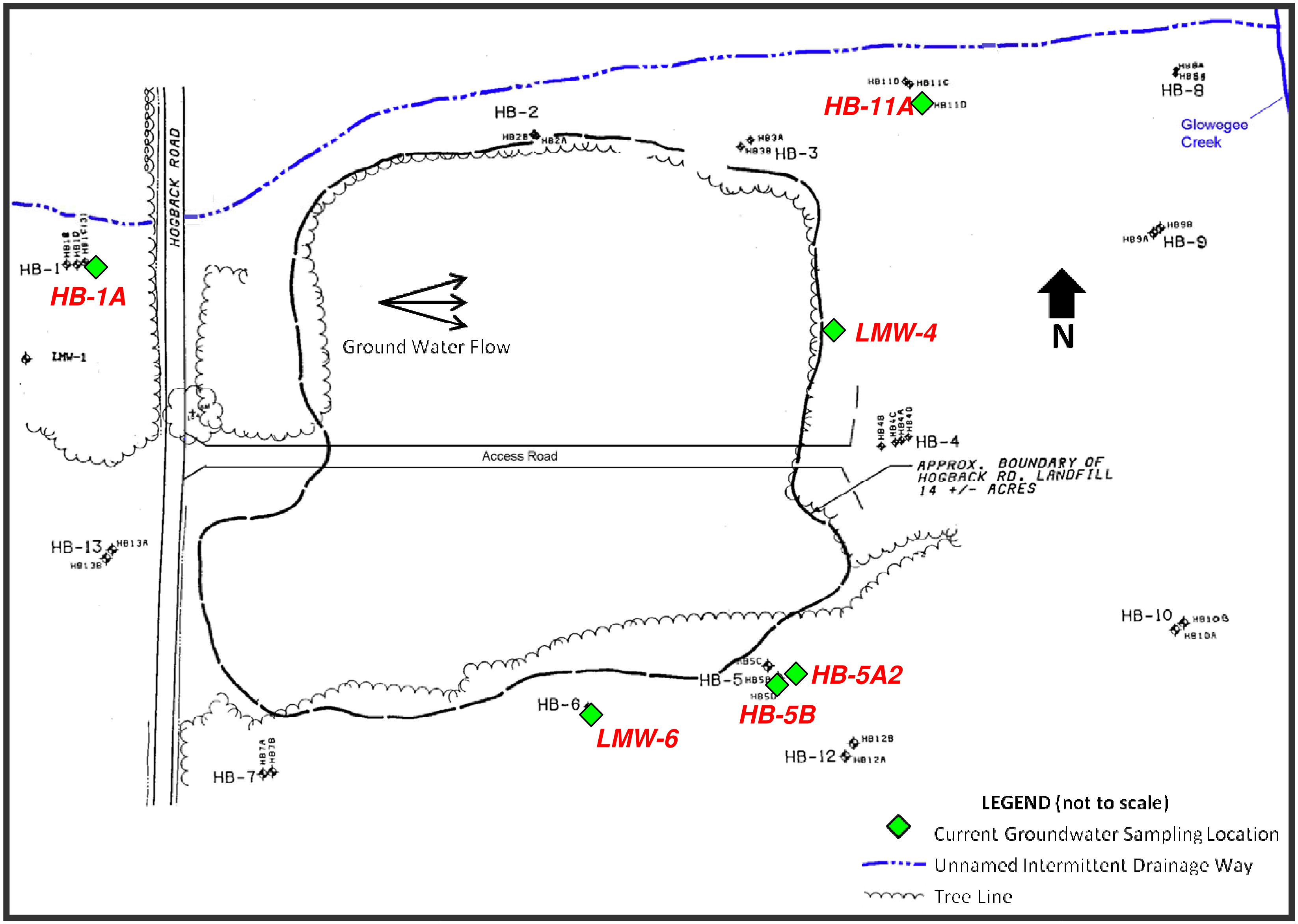


**Figure 5-3**
**Kesselring Site, Near West Milton, New York**
**Landfill Groundwater Monitoring Wells**

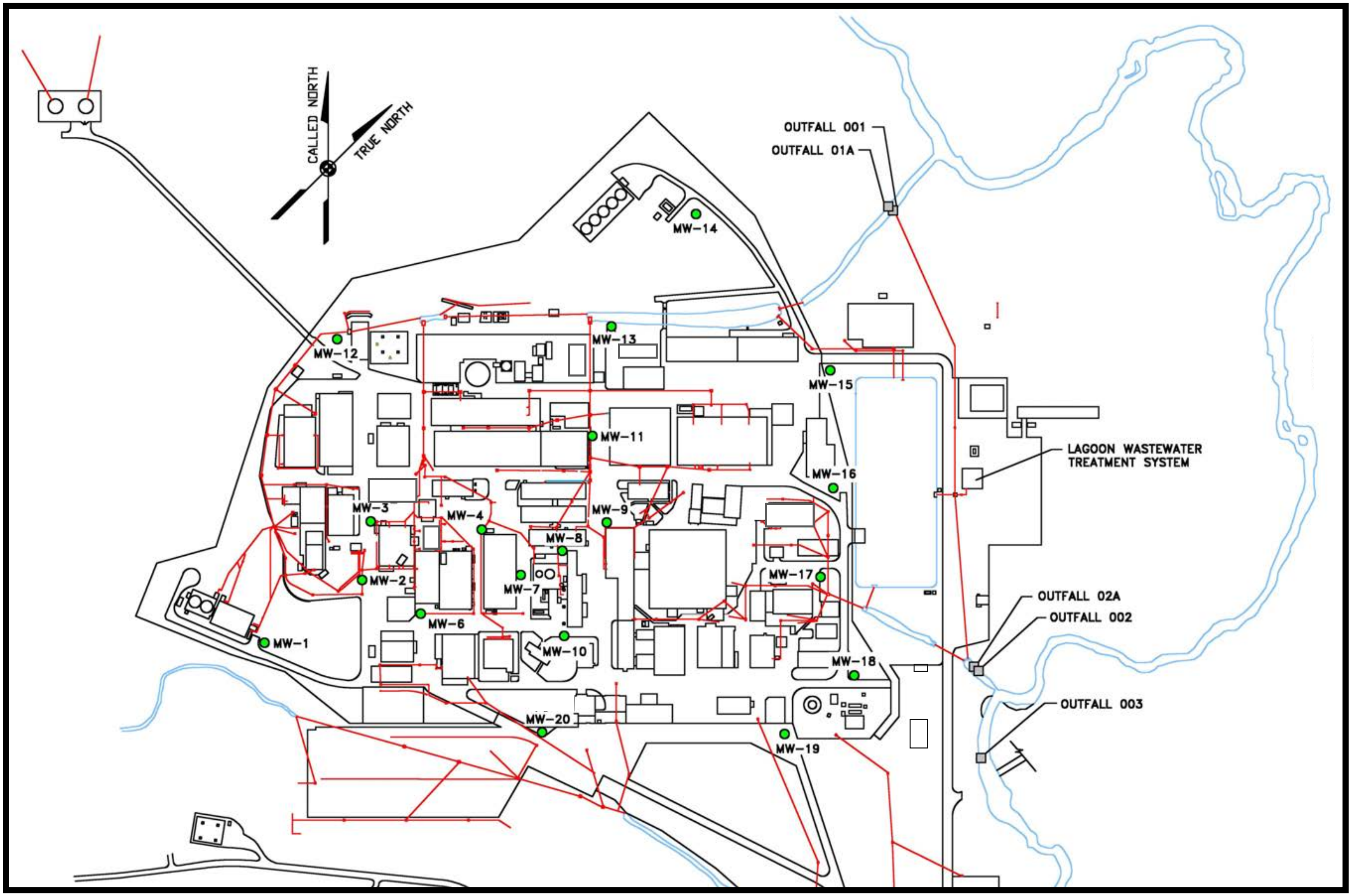


**Figure 5-4**
**Kesselring Site, Near West Milton, New York**
**Developed Area Groundwater Monitoring Wells**

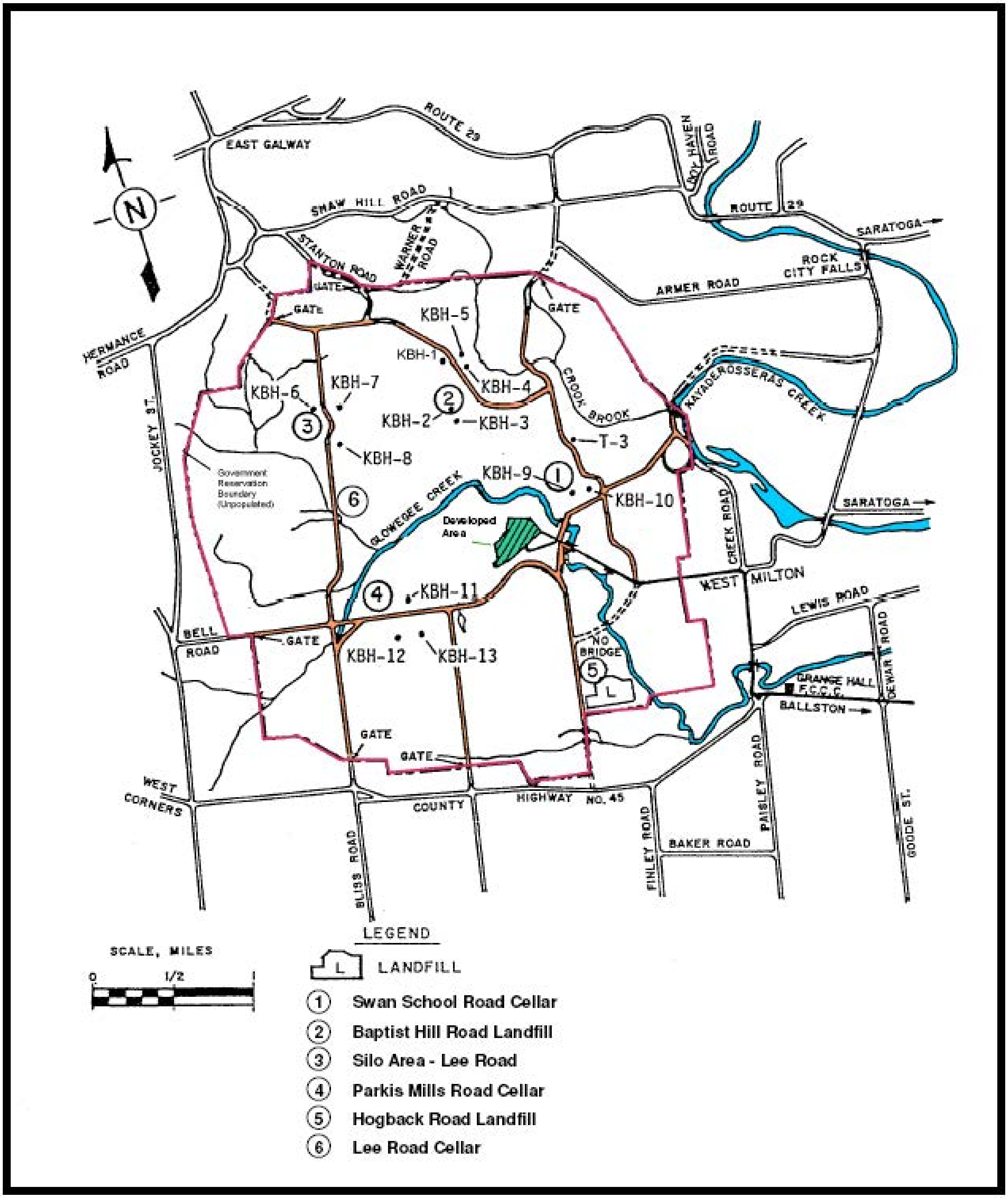


**Figure 5-5**
**Kesselring Site, Near West Milton, New York**
**Disposal Areas - Groundwater Monitoring Wells**

Landfill samples are analyzed for a modified list of routine chemical and leachate-indicator parameters approved by NYSDEC in 2002. The modified routine parameter list includes alkalinity, ammonia-N, chemical oxygen demand (COD), chloride, hardness, nitrate-N, sulfate, total dissolved solids (TDS), total organic carbon (TOC), calcium, iron, manganese, magnesium, potassium, and sodium. The samples are also analyzed for halogenated and aromatic volatile organic compounds (VOCs). All samples were collected in accordance with the procedures and requirements of the Post-Closure Monitoring and Maintenance Operations Manual. All routine parameter results are shown in Table 5-11. Gas monitoring was performed at the landfill in accordance with the post-closure monitoring requirements using an oxygen/explosive gas detector calibrated to the manufacturer's specifications.

Within the developed area, the 19 monitoring wells are sampled for both halogenated and aromatic VOCs. The VOC analysis suite consists of 29 halogenated and 5 aromatic compounds of which only a few have been detected above the practical quantitation limit in the past. VOC results are shown in Table 5-12.

Groundwater from three production wells located along the Site's eastern property boundary is used to supply the drinking water system at the Kesselring Site. The drinking water is sampled in accordance with New York State drinking water regulations defined in Reference (20). The sample results are shown in Table 5-13.

**Radiological:** The Kesselring Site conducts voluntary radiological monitoring on the groundwater wells at the landfill area, the developed area, and four former disposal sites. The well locations are shown in Figures 5-3, 5-4, and 5-5. The well samples are analyzed by gamma spectrometry for cesium-137 and cobalt-60 and by liquid scintillation spectrometry for tritium. The results of the analyses are shown in Table 5-14.

### 5.6.4 Assessment

**Nonradiological:**

**<u>Landfill</u>**

Groundwater wells were sampled both upgradient and downgradient of the Hogback Road Landfill to monitor groundwater quality impacts from the landfill and for any indications of a breach in the integrity of the landfill cap. Analytical results obtained during 2013 remain consistent overall with historical data trends.

The 2013 analytical results continue to show that while certain routine parameters remain elevated in most of the downgradient wells when compared to the upgradient well (HB-1A) (Table 5-11), these parameters are either stable or decreasing over time, and that there remains no indication of a breach in landfill cap integrity. The individual parameters that are typically elevated include: specific conductance, alkalinity, hardness, TDS, chloride, sulfate, magnesium, manganese, potassium, sodium, calcium, and VOCs. A number of other parameters exhibit variability and are generally elevated in only a few downgradient wells. These parameters routinely include turbidity, COD, TOC, ammonia, nitrate, iron, and VOCs.

While a number of parameters continue to exceed groundwater quality standards per Reference (1) or guidance values per Reference (21), inorganic parameters detected in downgradient well samples are within, or below, representative ranges for inorganic parameters typical of leachate from sanitary landfills per Reference (12). VOC analytical results obtained during 2013 remain consistent with historical data trends.

Ambient air gas monitoring was performed at the landfill gas vents. No detectable concentrations of explosive gases were observed. Quarterly landfill inspections were conducted and no degradation or breaches in the cap were identified. Routine landfill maintenance was performed to ensure continued integrity of the landfill cap.

## TABLE 5-11 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, HOGBACK ROAD LANDFILL, 2013(1)

ROUTINE PARAMETERS (2002 MODIFIED LIST)

| Sample Location | HB-1A | LMW-4 | HB-11A | HB-5A2 | HB-5A2 Duplicate | HB-05B | LMW-6 | Standard /Criteria(2) |
|---|---|---|---|---|---|---|---|---|
| Sample Date | 9/09/13 | 9/09/13 | 9/09/13 | 9/09/13 | 9/09/13 | 9/09/13 | 9/09/13 | |
| **Field Parameters** | | | | | | | | |
| Groundwater Elev. (ft) | 480.80 | 464.78 | 460.04 | 451.46 | ---- | 451.25 | 460.48 | NC |
| Temperature ($^o$C) | 16.0 | 13.0 | 14.0 | 11.0 | ---- | 13.0 | 11.0 | NC |
| pH (SU) | 6.3 | 6.6 | 6.8 | 6.3 | ---- | 6.5 | 6.3 | 6.5-8.5 |
| Specific Conductance (µmhos/cm) | 144 | 1040 | 927 | 1079 | ---- | 1366 | 1162 | NC |
| Turbidity (NTU) | 7 | 569 | 74 | 43 | ---- | 19 | 22 | 5 |
| **Indicator (mg/l, or as indicated)** | | | | | | | | |
| Alkalinity, as CaCO3 | 50 | 620 | 390 | 490 | 220 | 570 | 500 | NC |
| Ammonia-N | <0.1 | 0.5 | <0.1 | 0.1 | <0.1 | 0.3 | <0.1 | 2 |
| COD | 9 | 130 | <5 | <5 | <5 | <5 | <5 | NC |
| Chloride | <1.00 | 4.78 | 35.3 | <1.00 | <1.00 | 76.5 | 24.1 | 250 |
| Hardness, as CaCO3 | 56 | 557 | 377 | 474 | 489 | 474 | 374 | NC |
| Nitrate-N | 0.02 | 0.72 | <0.02 | 0.78 | 0.72 | 0.63 | 0.02 | 10 |
| Sulfate | 7.28 | 8.40 | 6.92 | 4.60 | 4.56 | 7.47 | 3.48 | 250 |
| TDS | 55 | 530 | 465 | 540 | 540 | 695 | 155 | 500 |
| TOC | 3.8 | 19.0 | 1.9 | 1.8 | 1.8 | 2.8 | 2.3 | NC |
| **Metals (mg/l)(4)** | | | | | | | | |
| Calcium | 17.5/18.5 | 186/151 | 115/115 | 169/172 | 174/172 | 144/147 | 117/120 | NC |
| Iron | 0.149/<0.050 | 6.47/0.484 | 0.314/0.062 | 2.71/0.317 | 2.75/0.355 | 3.34/0.735 | 0.358/<0.050 | 0.3 |
| Magnesium | 3.09/3.30 | 22.3/20.3 | 21.8/21.9 | 12.6/12.7 | 13.2/12.6 | 27.9/28.2 | 19.8/20.1 | 35.0(g)(5) |
| Manganese | <0.020/<0.020 | 0.700/0.511 | 0.196/0.061 | 2.38/2.30 | 2.35/2.33 | 0.537/0.522 | 0.805/0.549 | 0.3 |
| Potassium | 0.698/0.728 | 3.85/3.58 | 1.28/1.27 | 2.12/1.93 | 2.53/1.82 | 3.24/4.72 | 1.88/1.86 | NC |
| Sodium | 1.37/1.29 | 16.3/14.0 | 20.8/20.8 | 8.65/7.56 | 8.11/7.51 | 81.0/83.0 | 75.3/56.6 | 20 |
| **Volatiles (µg/l)(6)(7)** | | | | | | | | |
| 1,1- Dichloroethane | <1.0 | 1.6 | <1.0 | 1.6 | 1.7 | <1.0 | <1.0 | 5 |
| Chloroethane | <1.0 | <1.0 | <1.0 | 6.3 | 6.5 | 2.6 | <1.0 | 5 |
| Dichlorodifluoro-methane | <1.0 | 2.5 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 5 |

## NOTES for TABLE 5-11

(1) Compounds that are not detected at or above the practical quantitation limit are reported in the table as less than (<) the practical quantitation limit.

(2) Groundwater standards taken from 6NYCRR Part 703.3, dated September 1991 (applicable regulations at time of Landfill closure) and from Part 703.5 dated April 1999. Additional water standards and guidance values taken from Technical & Operational Guidance Series (TOGS) 1.1.1, Ambient Water Quality Standards and Guidance Values, Revised; June 1998.

(3) (Deleted)

(4) Total metal sample analysis data is shown preceding the dissolved metal result, i.e., total /dissolved. In some cases, the dissolved data is shown to be slightly higher than the total data. The laboratory has stated that these data are correct, and that the total and dissolved results are within the margin of error for the analytical procedures.

(5) (g) = Groundwater Guidance Value.

(6) VOCs analyzed but not detected at or above the practical quantitation limit in any of the presented sampling rounds are not listed in the table.

(7) VOCs analyzed using method EPA SW-846 Method 8021B beginning in 2006. EPA Method 601 had been used in previous years.

NC = No Criteria Available (no standards or guidance values per 6NYCRR Part 703 or TOGS 1.1.1)
- - No Analysis Data

| | |
|---|---|
| mg/l = milligrams / liter | COD = Chemical Oxygen Demand |
| µg/l = micrograms / liter | TDS = Total Dissolved Solids |
| µmhos/cm = micromhos / centimeter | TOC = Total Organic Carbon |
| ntu = nephelometric turbidity units | SU = Standard Units |

**TABLE 5-12 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, DEVELOPED AREA WELLS, 2013 [3][4][5]**

| Well | Sample Date | Chloro-form (µg/l) | Trichloro-ethene (µg/l) |
|---|---|---|---|
| MW-1[1] | 8/20/13 | 6.2 | <1.0 |
| MW-4 | 8/20/13 | <1.0 | 3.8 |
| Standard [2] | | 7 | 5 |
| PQL | | 1.0 | 1.0 |

Notes:
(1) Upgradient well.
(2) Groundwater standards from 6NYCRR Part 703.5 and Division of Water, Technical Operation Guidance Series (TOGS) (1.1.1) Ambient Water Quality Standards and Guidance Values.
(3) All samples were analyzed by EPA methods 601 and 602.
(4) VOCs analyzed but not detected at or above the practical quantitation limit in any of the presented sampling rounds are not listed in the table.
(5) Compounds that are not detected at or above the practical quantitation limit are reported in the table as less than (<) the practical quantitation limit.

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## Developed Area

The routine annual groundwater program for the developed area includes field parameters and VOC analyses as discussed in Section 5.6.3. Field parameters include groundwater elevation, temperature, and pH. Analyses for specific conductance, turbidity, chloride, nitrogen-nitrate, nitrogen-ammonia, and nitrogen-nitrite were performed at an off-site laboratory.

Samples are analyzed for VOCs utilizing EPA methods 601 and 602. Several VOCs continue to be detected in low part per billion (ppb; µg/l) concentrations. Results ranged from below the practical quantitation limit of less than 1 ppb to 6.3 ppb. Analytical results are presented in Table 5-12. The table presents only those volatile compounds that have been detected at or above the laboratory's practical quantitation limit.

VOC analysis detected one trihalomethane (THMs) compound at a concentration of 6.2 ppb in MW-1. The THMs are considered to be the result of past fire hydrant flushing (with chlorinated Site service water) and/or cooling tower drift (which also uses chlorinated water) contacting natural humic material in soil upgradient of well MW-1.

Due to high levels of ammonia detected in groundwater during the construction of Building 102, groundwater discharged from the Building 102 drainage system is treated for ammonia and nitrite in a facility that was completed and opened for use in 2011. From 2007 to 2011, ammonia concentration ranged between 3.8 and 22.4 mg/L. The highest concentrations were experienced in January 2007. The source of the ammonia has not been specifically identified. Groundwater ammonia levels have been slowly decreasing since 2007, and ranged between 0.7 mg/L to 2.6 mg/L in 2013.

**Site Service (Drinking) Water**

The drinking water supply is part of the site service water (SSW) system and is supplied from a deep (confined) groundwater aquifer. The drinking water system is sampled and monitored to ensure its quality meets New York State Department of Health drinking water regulations (Reference (20)). The sample results are shown in Table 5-13. The SSW well field is hydrogeologically separate from the Site landfill and former disposal sites and is consequently not affected by materials at those locations.

**Radiological:**

The groundwater sample results for radioactivity are summarized in Table 5-14. The levels of cesium-137, cobalt-60, and tritium were below decision level concentrations in all wells. The concentrations for these radionuclides were less than 0.1 percent of the respective Reference (4) derived concentration guide values.

**Conclusion**:

The 2013 groundwater data demonstrate no adverse changes from historical monitoring results. Past waste disposal practices at the landfill have resulted in observable effects on groundwater quality downgradient of the landfill. However, data trends show that groundwater quality has improved since the landfill was closed and that there is no indication of a breach in landfill cap integrity.

Monitoring results within the developed area show that some parameters are elevated. These results are attributed to normal operations of the Kesselring Site that include the continued use of chlorinated Site service water for drinking, fire protection, and system cooling needs, the operation of the Site cooling towers, as well as limited effects from past operational practices.

## TABLE 5-13 CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 2013

| Parameter/Units[2] (Units are mg/l unless otherwise noted) | Number of Samples | Value[1] Minimum | Maximum | Average[3] | Standard[4] | Percent of Standard[5] |
|---|---|---|---|---|---|---|
| **Drinking Water Standards (Reference 20)** | | | | | | |
| Nitrates (mg/L as N) | 1 | 0.494 | 0.494 | 0.494 | 10 | 5.0 |
| Nitrites (mg/L as N) | 1 | <0.01 | <0.01 | <0.01 | 1 | <1 |
| Total Coliform[6,7] (CFU/100ml) | 36 | <1 | <1 | <1 | None Detectable | N/A |
| Free Chlorine Residual | 365 | 0.53 | 4.10 | 1.57 | (8) | N/A |
| Free Chlorine Residual[7] | 36 | 0.87 | 2.20 | 1.68 | (8) | N/A |
| Benzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Bromobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Bromochloromethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Bromodichloromethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Bromoform[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Bromomethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| n-Butylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| sec-Butylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| tert-Butylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Carbon Tetrachloride[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Chlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Chloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Chloroform (Trichloromethane)[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Chloromethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 2-Chlorotoluene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 4-Chlorotoluene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Dibromochloromethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Dibromomethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2-Dichlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,3-Dichlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,4-Dichlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Dichlorodifluoromethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1-Dichloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2-Dichloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1-Dichloroethene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| cis-1,2-Dichloroethene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| trans-1,2-Dichloroethene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2-Dichloropropane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,3-Dichloropropane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 2,2-Dichloropropane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1-Dichloropropene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| cis-1,3-Dichloropropene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| trans-1,3-Dichloropropene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Ethylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |

## TABLE 5-13 CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 2013 (Continued)

| Parameter/Units[2] (Units are mg/l unless otherwise noted) | Number of Samples | Value[1] Minimum | Maximum | Average[3] | Standard[4] | Percent of Standard[5] |
|---|---|---|---|---|---|---|
| **Drinking Water Standards (Reference 20)** | | | | | | |
| Hexachlorobutadiene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Isopropylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 4-Isopropyltoluene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Methylene Chloride[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Methyl Tertiary Butyl Ether[9] | 2 | <0.002 | <0.002 | <0.002 | 0.01 | <20 |
| Naphthalene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| n-Propylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Styrene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1,1,2-Tetrachloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1,2,2-Tetrachloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Tetrachloroethene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Toluene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1,1-Trichloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,1,2-Trichloroethane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Trichloroethene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Trichlorofluoromethane | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2,3-Trichloropropane[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2,3-Trichlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2,4-Trichlorobenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,2,4-Trimethylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| 1,3,5-Trimethylbenzene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Vinyl Chloride[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.002 | <25 |
| m, p-Xylene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| o-Xylene[9] | 2 | <0.0005 | <0.0005 | <0.0005 | 0.005 | <10 |
| Haloacetic Acids[10] | 1 | <0.01 | <0.01 | <0.01 | 0.06 | <17 |
| Total Trihalomethanes[10] | 1 | <0.02 | <0.02 | <0.02 | 0.08 | <25 |

**Notes:**

(1) A value preceded by "<" is less than the practical quantitation limit for that sample and parameter.
(2) All samples were collected at the entry point to the distribution system unless otherwise noted.
(3) Average values preceded by "<" contain at least one less than practical quantitation limit value in the average.
(4) Maximum Contaminant Level (MCL) per 10 NYCRR Subpart 5-1 Public Water Systems.
(5) Percent of standard for the average value.
(6) The minimum detectable concentration by the membrane filter method is one colony per 100 ml (N/100 ml).
(7) These samples are taken at various locations in the site distribution system when routine total coliform samples are collected.
(8) The minimum specification is that the free chlorine residual is 0.2 mg/L at the entry point and detectable in the distribution system. The maximum average level is 4 mg/L as calculated by taking the annual average, computed quarterly, of the samples collected in the distribution system.
(9) These samples were taken from Well #1 and Well #7 in the Site Drinking Water System.
(10) These samples are collected from the Head Tank 27B (Storage Tank B).

## TABLE 5-14 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING FOR RADIOACTIVITY[1], 2013

| LOCATION | | Cs-137 | Co-60 | Tritium |
|---|---|---|---|---|
| | | pCi/liter | | pCi/liter x$10^2$ |
| **LANDFILL AREA** | | | | |
| HB-1A[2] | | < 0.87 | < 0.73 | <1.58 |
| HB-1B[2] | Not Sampled | | | |
| HB-5A2 | | < 0.86 | < 0.73 | <1.58 |
| HB-5B | | < 0.84 | < 0.73 | <1.58 |
| HB-11A | | < 0.84 | < 0.70 | <1.58 |
| HB-11B | Not Sampled | | | |
| LMW-4 | | <0.84 | <0.73 | <1.58 |
| LMW-6 | | < 0.85 | < 0.71 | <1.58 |
| **DEVELOPED AREA** | | | | |
| MW-1[2] | | < 0.84 | < 0.71 | <1.59 |
| MW-2 | | < 0.88 | < 0.75 | <1.59 |
| MW-3 | | < 0.85 | < 0.70 | <1.59 |
| MW-4 | | < 0.85 | < 0.72 | <1.59 |
| MW-6 | | < 0.86 | < 0.73 | <1.59 |
| MW-7 | | < 0.86 | < 0.72 | <1.59 |
| MW-8 | | < 0.85 | < 0.72 | <1.59 |
| MW-9 | | < 0.84 | < 0.72 | <1.59 |
| MW-10 | | < 0.85 | < 0.71 | <1.59 |
| MW-11 | | < 0.85 | < 0.71 | <1.59 |
| MW-12 | | < 0.84 | < 0.70 | <1.59 |
| MW-13 | | < 0.85 | < 0.73 | <1.59 |
| MW-14 | | < 0.83 | < 0.73 | <1.59 |
| MW-15 | | < 0.85 | < 0.74 | <1.59 |
| MW-16 | | < 0.84 | < 0.70 | <1.59 |
| MW-17 | | < 0.86 | < 0.76 | <1.59 |
| MW-18 | | < 0.82 | < 0.71 | <1.59 |
| MW-19 | | < 0.83 | < 0.71 | <1.59 |
| MW-20 | | < 0.85 | < 0.73 | <1.59 |
| **BAPTIST HILL ROAD LANDFILL** | | | | |
| KBH-1[2] | | < 0.88 | < 0.72 | <1.61 |
| KBH-2 | | < 0.86 | < 0.76 | <1.61 |
| KBH-3 | | < 0.96 | < 0.81 | <1.58 |
| KBH-4 | | < 0.87 | < 0.71 | <1.61 |
| **SILO AREA** | | | | |
| KBH-6[2] | | < 0.85 | < 0.73 | <1.61 |
| KBH-7 | | < 0.83 | < 0.72 | <1.61 |
| KBH-8 | Well Dry, Not Sampled | | | |
| **SWAN SCHOOL ROAD CELLAR** | | | | |
| KBH-9 | | < 0.94 | < 0.77 | <1.61 |
| KBH-10 | | < 0.90 | < 0.74 | <1.61 |
| T-3 | Well Dry, Not Sampled | | | |
| **PARKIS MILLS ROAD CELLAR** | | | | |
| KBH-11 | | < 0.85 | < 0. 74 | <1.61 |
| KBH-12 | Well Dry, Not Sampled | | | |
| KBH-13 | | < 0.86 | < 0.73 | <1.61 |

Notes: (1) A value preceded by "<" is less than the decision level concentration for that sample and parameter.
(2) Background well for comparison purposes.

## 5.7 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES AND SOLID WASTE

### 5.7.1 Chemical Control Program

Chemicals are not manufactured or disposed of at the Kesselring Site. To ensure the safe use of chemicals and disposal of the resulting wastes, the Kesselring Site maintains hazardous substance control and waste minimization programs similar to those at the Knolls Site. Since 1990, significant reductions in hazardous waste streams have been accomplished at the Kesselring Site. Some hazardous waste streams have been eliminated through the use of non-hazardous substitutes. Most notably, a corrosive waste stream was eliminated by a process change, to make demineralized water by reverse osmosis rather than ion exchange. Hazardous substance storage controls include as a minimum: labeling, revetment as appropriate, segregation based on compatibility, limited storage volumes, and weather protection, as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations as specified in Reference (13) and the Petroleum Bulk Storage regulations in Reference (14). Minimal quantities of hazardous wastes do result from the necessary use of chemicals in Site operations. Larger quantities of hazardous wastes result from one-time facility decommissioning and dismantlement activities. Hazardous and mixed (radioactive and hazardous) waste storage facilities are operated at the Kesselring Site under provisions of the New York State regulation implementing the Resource Conservation and Recovery Act (RCRA) and the Federal Facility Compliance Act. The Kesselring Site operates a hazardous waste storage facility and a mixed radioactive and hazardous waste storage facility under a Part 373 permit issued by NYSDEC. During 2013, the Kesselring Site shipped approximately 15 tons of RCRA and New York State hazardous waste offsite for treatment and disposal. This includes approximately 3.6 tons of mixed waste, predominantly from facility decommissioning and dismantlement activities.

Elementary neutralization of small volume laboratory waste also occurs on-site. This process is exempt from regulation as a RCRA treatment process. The neutralized discharge is controlled under the Kesselring Site SPDES permit.

Nonhazardous chemical waste is also sent off-site for disposal. The transportation vendors and the treatment/storage/disposal facilities are typically the same as those used for hazardous waste disposal. These facilities also operate under permits issued by the cognizant Federal and State regulatory agencies. KAPL also requires the disposal facility to provide itemized written verification that the waste was actually received. Approximately 21 tons of nonhazardous chemical waste was sent for offsite treatment and disposal via incineration, wastewater treatment, chemical treatment and/or land disposal. A significant fraction of these wastes was the result of either dismantlement and/or renovation activities at the Kesselring Site.

In addition, the Kesselring Site hazardous waste control program is subject to periodic on-site inspections by NYSDEC and the EPA.

### 5.7.2 Solid Waste Disposal/Recycling

During 2013, approximately 2246 tons of nonhazardous, non-recycled, solid wastes were generated from such waste streams as: construction and demolition debris, office and cafeteria trash, and classified paper. The Kesselring Site recycles such products as all paper except classified items, glass, plastic, aluminum, newspapers, magazines, scrap metal, corrugated cardboard, computers, precious metals, lead, oil, fluorescent light bulbs, wood, asphalt, printer cartridges, and batteries. Approximately 486 tons of materials were recycled.

## 5.8 CONTROL OF RADIOACTIVE MATERIALS AND RADIOACTIVE WASTE

### 5.8.1 Sources

Operations at the Kesselring Site result in the generation of various types of radioactive materials and wastes. Low level radioactive solid waste material that requires disposal includes filters, metal scrap, resin, rags, paper, and plastic materials.

### 5.8.2 Control Program

Detailed procedures are used for handling, packaging, and transportation of radioactive materials and for disposal of radioactive waste at a government operated or licensed disposal site. Internal reviews are made prior to the shipment of any radioactive material from the Site to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal, State, and local requirements.

The volume of radioactive waste is minimized through recycling and the use of special work procedures that limit the amount of material that becomes contaminated during work on radioactive systems and reactor components. Radioactive liquid waste is processed into an absorbed form prior to shipment to an approved disposal facility. All radioactive wastes are prepared and shipped to meet applicable regulations of the DOT given in Reference (15). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

### 5.8.3 Disposal/Recycling

The shipments of low level radioactive solid wastes were made by authorized common carriers to disposal sites located outside of New York State.

During 2013, approximately 787 cubic meters (1030 cubic yards) of low level radioactive waste containing 0.183 curies was shipped from the Site for disposal. The Kesselring Site did not ship any radioactive metal for radioactive material recycling.

## 5.9 CONTROL OF MIXED WASTES

### 5.9.1 Sources

A mixed waste is a waste that contains both radioactive and hazardous materials, as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA). Also per the New York State Department of Environmental Conservation, certain Toxic Substances Control Act (TSCA) regulated PCB waste is also considered a hazardous waste. Ongoing operations at the Kesselring Site resulted in the generation of a very small proportion of the mixed waste generated at Kesselring. The majority of the mixed waste is generated as a result of dismantlement or refurbishment activities.

### 5.9.2 Control Program

Since mixed wastes are both RCRA hazardous and radioactive, the controls for hazardous wastes are applied to the hazardous constituents and the controls for radioactive wastes are applied to the radioactive constituents.

Mixed wastes are managed on-site in accordance with the Kesselring Site RCRA permit. The amount of mixed waste generated was minimized through the use of detailed work procedures and worker training. Mixed wastes were collected in designated regulated and permitted storage areas for the sole purpose of accumulating sufficient quantities to facilitate shipment to an off-site facility for proper treatment and disposal.

### 5.9.3 Disposal

Mixed wastes shipped offsite were packaged in compliance with DOT requirements for transport to, and receipt at RCRA-permitted treatment and disposal facilities. In 2013, there were 6 shipments totaling 3.5 tons of various mixed wastes sent to treatment and disposal facilities.

## 5.10 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that the radioactivity in liquid and gaseous effluents from 2013 operations at the Kesselring Site had no measurable effect on background radioactivity levels. Therefore, any radiation doses from Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of the radiation dose to the maximally exposed off site individual in the vicinity of the Kesselring Site, and the collective dose to the population residing in the 80 kilometer (50 mile) radius assessment area are summarized in Section 7.0, Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the DOE radiation protection standards listed in Reference (4) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Kesselring Site was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole body dose demonstrating that doses are as low as reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (6).

The collective radiation dose to the public along travel routes from Kesselring Site shipments of radioactive materials during 2013 was calculated using data given by the NRC in Reference (17).

Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. This is less than 0.001 percent of the dose received by the same population from natural background radiation.

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# 6.0 SEPARATIONS PROCESS RESEARCH UNIT ENVIRONMENTAL MONITORING

## 6.1 BACKGROUND

A Cold War era facility known as the Separations Process Research Unit (SPRU) operated between 1950–1953 at the Knolls Site as a pilot plant to research chemical processes to extract uranium and plutonium from irradiated uranium. The SPRU work was conducted under the direction of the Atomic Energy Commission. The work was done on a limited scale; SPRU was never a production plant. The SPRU processes were developed for use at the Atomic Energy Commission's Hanford Site in Washington State and the Savannah River Plant in South Carolina.

Following cessation of SPRU operations in 1953, partial cleaning of equipment and systems was performed, and the facility was placed in a stable long-term storage condition by the Atomic Energy Commission. KAPL maintained an environmental monitoring program to confirm that the inactivated SPRU facility posed no threat to the health of Laboratory workers, the public, or the environment.

Consistent with its objective to clean up legacy sites that are no longer needed, the Department of Energy Office of Environmental Management (DOE-EM) dedicated funding to support SPRU dismantlement and remediation. The remediation of the SPRU facility and waste management areas will result in the removal of hazardous equipment, building materials, and impacted soil from the Knolls Site and restoration of the land for KAPL use. KAPL turned over the SPRU facilities (Buildings G2 and H2) and land areas to DOE-EM as necessary to support the objectives of the cleanup work. DOE-EM is responsible for the remediation of the SPRU areas, which are shown on Figure 6-1.

During 2013, installation of the H2 enclosure was completed on the Upper Level, involving soil excavation and drilling of micropile supports. Approximately 303 cubic meters (404 cubic yards) of excavated material and drilling spoils were packaged and shipped for off-site disposal. No net radioactivity above background was reported on package surveys.

The nature of the work performed during 2013 in the Building G2/H2 area consisted of operating radioactive water processing systems, maintenance of the facility, removal of legacy radioactive materials, remediation of hazardous materials, and preparations for the demolition of Buildings G2 and H2. In 2013, the work scope also included maintenance of contamination controls and shipments of wastes.

## 6.2 LIQUID EFFLUENT MONITORING

### 6.2.1 Sources

**Non-radiological**: The principal source of non-radiological effluent water from SPRU is stormwater to the Mohawk River.

**Radiological:** The main source of radiological water is groundwater which is collected around the foundation of Building H2 and rainwater/groundwater that enters the H2 Building. Water from the SPRU facilities has been shipped off-site to approved disposal facilities. In 2013, a total of 216,110 gallons of water was shipped off-site for treatment and disposal.

### 6.2.2 Effluent Monitoring

Effluent monitoring is performed by KAPL and is described in Knolls Laboratory section 4.2.2.

### 6.2.3 Effluent Analyses

Effluent analyses are performed by KAPL and are described in Knolls Laboratory section 4.2.3.

### 6.2.4 Assessment

See section 4.2.4.

## 6.3 AIRBORNE EFFLUENT MONITORING

### 6.3.1 Sources

**Non-radiological:** The principal source of non-radiological air emissions at SPRU are emergency and non-emergency diesel generators. This source of air emissions at SPRU meets the criteria for exempt and trivial sources under NYSDEC regulations and is not required to have air permits or registrations.

**Radiological:** The SPRU operations capable of generating airborne radioactivity include the operation of water processing systems, installation of the H2 enclosure, decontamination and demolition activities associated with Portable Ventilation Units (PVUs) and the G2 and H2 enclosures, and soil excavation. Both enclosures and the PVUs are permitted point sources. Water processing and soil excavation are sources of fugitive emissions.

### 6.3.2 Effluent Monitoring

**Non-radiological:** In general, exempt and trivial activities do not require emissions monitoring, although some activities such as operation of the diesel generators may require monitoring of run times to maintain their exempt status.

**Radiological:** The airborne effluents from portable ventilation unit (PVU) operations were continuously sampled for particulate radioactivity. The Building G2 ventilation system was operational throughout 2013. The Building H2 ventilation system began operation on February 28, 2013. Airborne effluents were continuously sampled for particulate activity after start-up. Emissions from diffuse sources were estimated using EPA methods.

### 6.3.3 Effluent Analyses

**Radiological:** Particulate filter papers from PVUs and the G2 and H2 ventilation systems were analyzed using a sensitive low-background gas proportional counting system. Follow-on analyses for specific radionuclides were performed quarterly. The H2 building enclosure ventilation was incorporated into the monitoring program after starting operations on February 28, 2013.

### 6.3.4 Assessment

**Radiological:** The radioactivity released in SPRU airborne effluent during 2013 is shown in Tables 6-1, 6-2, and 6-3 for the monitored effluents through PVUs, G2, and H2, respectively. Diffuse source emissions are summarized in Table 6-4. The releases from the PVU's, G2, H2, and diffuse sources are totaled in Table 6-5.

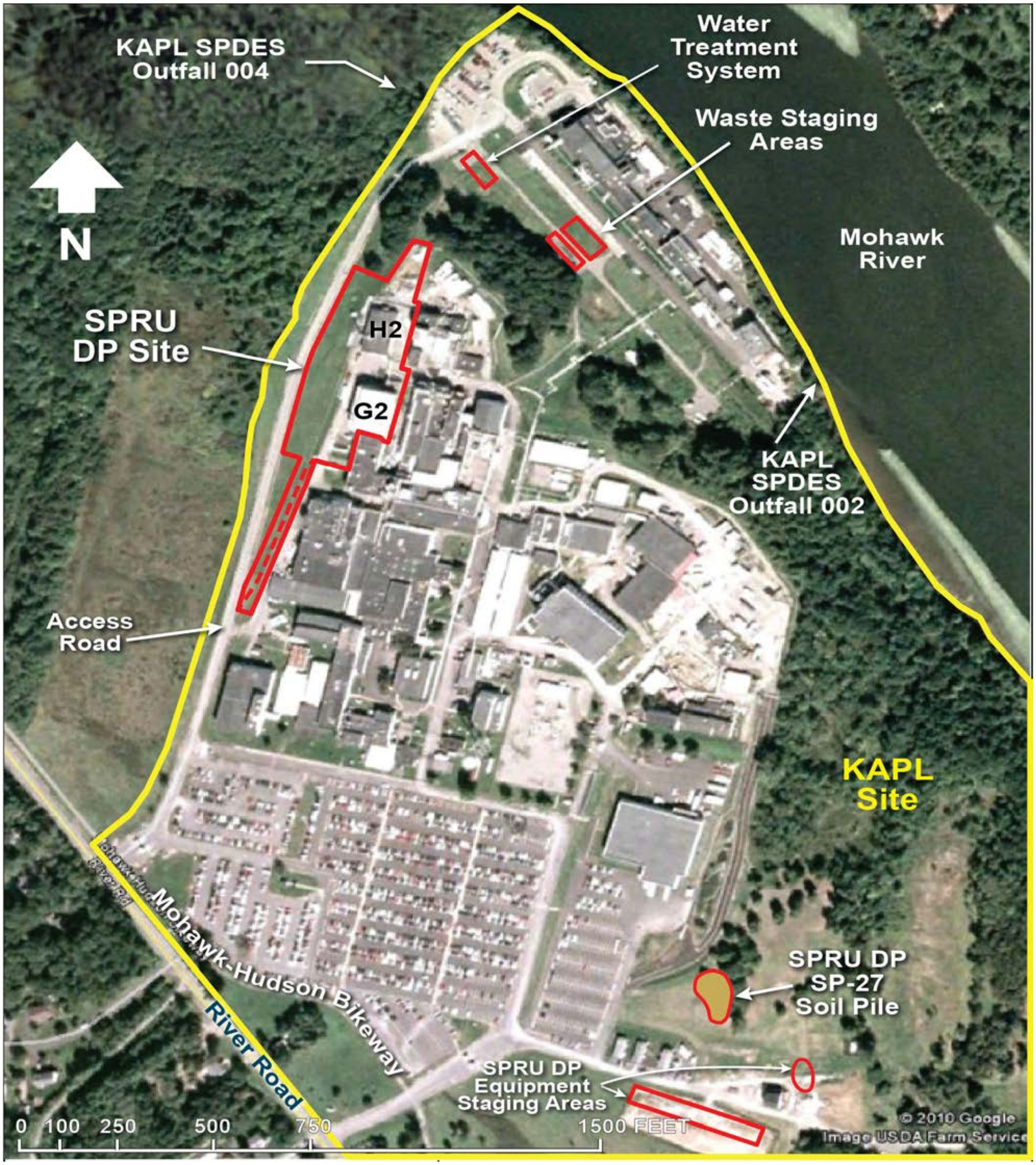


**Figure 6-1 SPRU Areas at the Knolls Site**

### TABLE 6-1 SPRU RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT FROM PORTABLE VENTILATION UNITS, 2013

| Radionuclide | Release Ci | Half-life |
|---|---|---|
| Sr-90 | 2.50E-10 | 28.78 years |
| Cs-137 | 2.01E-10 | 30.07 years |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | 2.01E-10 | |
| U-**233**/234 | 7.72E-11 | 1.59E05 years/2.46E05 years |
| U-235 | 2.62E-11 | 7.04E08 years |
| U-238 | 6.57E-11 | 4.47E09 years |
| Total Uranium | 1.69E-10 | |
| Pu-238 | 0.00E+00 | 87.7 years |
| Pu-**239**/240 | 1.95E-11 | 2.41E04 years/6.56E03 years |
| Total Plutonium (alpha) | 1.95E-11 | |
| Th-228 | 6.05E-11 | 1.91 years |
| Th-230 | 6.89E-11 | 7.34E04 years |
| Th-232 | 1.32E-11 | 1.40E10 years |
| Total Thorium | 1.43E-10 | |
| Am-241 | 1.66E-11 | 432.7 years |

**Bold** indicates radionuclide of interest in combined analyte.

### TABLE 6-2 SPRU RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT FROM G2 ENCLOSURE VENTILATION, 2013

| Radionuclide | Release Ci | Half-life |
|---|---|---|
| Sr-90 | 4.05E-08 | 28.78 years |
| Cs-137 | 2.40E-08 | 30.07 years |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | 2.40E-08 | |
| U-**233**/234 | 1.94E-08 | 1.59E05 years/2.46E05 years |
| U-235 | 3.56E-10 | 7.04E08 years |
| U-238 | 2.43E-08 | 4.47E09 years |
| Total Uranium | 4.41E-08 | |
| Pu-238 | 0.00E+00 | 87.7 years |
| Pu-**239**/240 | 1.37E-09 | 2.41E04 years/6.56E03 years |
| Total Plutonium (alpha) | 1.37E-09 | |
| Th-228 | 9.97E-09 | 1.91 years |
| Th-230 | 1.69E-08 | 7.34E04 years |
| Th-232 | 1.84E-08 | 1.40E10 years |
| Total Thorium | 4.53E-08 | |
| Am-241 | 3.79E-09 | 432.7 years |

**Bold** indicates radionuclide of interest in combined analyte.

## TABLE 6-3 SPRU RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT FROM H2 ENCLOSURE VENTILATION, 2013

(H2 Ventilation began operations 2/28/2013)

| Radionuclide | Release Ci | Half-life |
|---|---|---|
| Sr-90 | 2.03E-09 | 28.78 years |
| Cs-137 | 5.14E-08 | 30.07 years |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | 5.14E-08 | |
| U-**233**/234 | 3.95E-08 | 1.59E05 years/2.46E05 years |
| U-235 | 3.28E-09 | 7.04E08 years |
| U-238 | 4.21E-08 | 4.47E09 years |
| Total Uranium | 8.48E-08 | |
| Pu-238 | 1.65E-09 | 87.7 years |
| Pu-**239**/240 | 1.06E-09 | 2.41E04 years/6.56E03 years |
| Total Plutonium (alpha) | 2.71E-09 | |
| Th-228 | 3.23E-08 | 1.91 years |
| Th-230 | 1.63E-08 | 7.34E04 years |
| Th-232 | 3.59E-08 | 1.40E10 years |
| Total Thorium | 8.45E-08 | |
| Am-241 | 8.57E-10 | 432.7 years |

**Bold** indicates radionuclide of interest in combined analyte.

## TABLE 6-4 SPRU RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT FROM DIFFUSE SOURCES, 2013

| Radionuclide | Water Storage (Ci/yr) | Water Treatment (Ci/yr) | Building Resuspension Emissions (Ci/yr) | Soil/Debris (Ci/yr) | Diffuse Total (Ci/yr) |
|---|---|---|---|---|---|
| Sr-90 | 4.91E-06 | 3.30E-06 | 4.15E-06 | 1.15E-09 | 1.24E-05 |
| C-14 | 4.31E-09 | 2.89E-09 | | | 7.20E-09 |
| Ni-63 | 2.12E-09 | 1.43E-09 | | | 3.55E-09 |
| Tc-99 | 1.36E-09 | 9.11E-10 | | | 2.27E-09 |
| Cs-137 | 3.35E-06 | 2.25E-06 | | 4.52E-09 | 5.60E-06 |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | | | | | 5.60E-06 |
| U-233/234 | 1.63E-08 | 1.09E-08 | | 1.15E-10 | 2.73E-08 |
| U-235 | 9.69E-10 | 6.50E-10 | | 8.92E-12 | 1.63E-09 |
| U-238 | 9.55E-09 | 6.41E-09 | | 1.22E-10 | 1.61E-08 |
| Total Uranium | | | | | 4.50E-08 |
| Pu-238 | 5.80E-10 | 3.90E-10 | | 6.62E-12 | 9.76E-10 |
| Pu-239 | 4.57E-08 | 3.07E-08 | 3.47E-07 | 3.25E-10 | 4.24E-07 |
| Total Plutonium (alpha) | | | | | 4.24E-07 |
| Th-228 | 1.86E-09 | 1.25E-09 | | | 3.11E-09 |
| Th-230 | 1.30E-10 | 8.73E-11 | | | 2.17E-10 |
| Th-232 | 0.00E+00 | 0.00E+00 | | 1.03E-10 | 1.03E-10 |
| Total Thorium | | | | | 3.43E-09 |
| Am-241 | 3.25E-08 | 2.18E-08 | | 3.20E-11 | 5.44E-08 |
| Pu-241 | 2.21E-08 | 1.49E-08 | | | 3.70E-08 |
| Cm-242 | 1.91E-10 | 1.28E-10 | | | 3.19E-10 |

## TABLE 6-5 SPRU AIRBORNE RADIOACTIVITY RELEASED, 2013

| Radionuclide | G2 (Ci/yr) | H2 (Ci/yr) | PVU (Ci/yr) | Diffuse Total (Ci/yr) | Total Emissions (Ci/yr) |
|---|---|---|---|---|---|
| Sr-90 | 4.05E-08 | 2.03E-09 | 2.50E-10 | 1.24E-05 | 1.24E-05 |
| C-14 | | | | 7.20E-09 | 7.20E-09 |
| Ni-63 | | | | 3.55E-09 | 3.55E-09 |
| Tc-99 | | | | 2.27E-09 | 2.27E-09 |
| Cs-137 | 2.40E-08 | 5.14E-08 | 2.01E-10 | 5.60E-06 | 5.67E-06 |
| Fission and Activation Products ($T_{1/2}$ >3 hr) | | | | | 5.69E-06 |
| U-233/234 | 1.94E-08 | 3.95E-08 | 7.72E-11 | 2.73E-08 | 8.63E-08 |
| U-235 | 3.56E-10 | 3.28E-09 | 2.62E-11 | 1.63E-09 | 5.29E-08 |
| U-238 | 2.43E-08 | 4.21E-08 | 6.57E-11 | 1.61E-08 | 8.25E-08 |
| Total Uranium | | | | | 1.74E-07 |
| Pu-238 | | 1.65E-09 | 0.00E+00 | 9.76E-10 | 2.63E-09 |
| Pu-239 | 1.37E-09 | 1.06E-09 | 1.95E-11 | 4.24E-07 | 4.26E-07 |
| Total Plutonium (alpha) | | | | | 4.29E-07 |
| Th-228 | 9.97E-09 | 3.23E-08 | 6.05E-11 | 3.11E-09 | 4.54E-08 |
| Th-230 | 1.69E-08 | 1.63E-08 | 6.89E-11 | 2.17E-10 | 3.35E-08 |
| Th-232 | 1.84E-08 | 3.59E-08 | 1.32E-11 | 1.03E-10 | 5.44E-08 |
| Total Thorium | | | | | 1.33E-07 |
| Am-241 | 3.79E-09 | 8.57E-10 | 1.66E-11 | 5.44E-08 | 5.91E-08 |
| Pu-241 | | | 0.00E+00 | 3.70E-08 | 3.70E-08 |
| Cm-242 | | | | 3.19E-10 | 3.19E-10 |

## 6.4 ENVIRONMENTAL MONITORING

### 6.4.1 Scope

Environmental air samplers are operated by KAPL and are described in Knolls Laboratory section 4.4. Air samplers are operated within the SPRU work area and on the boundary between SPRU and Knolls Laboratory to confirm that SPRU work conforms to DOE regulations for exposure to workers and visitors.

## 6.5 RADIATION MONITORING

The environmental radiation monitoring program is performed by KAPL and is described in section 4.5.

## 6.6 GROUNDWATER MONITORING

The groundwater monitoring program is performed by KAPL and is described in section 4.6.

## 6.7 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

### 6.7.1 Sources

Chemicals are not manufactured at SPRU. To ensure the safe use of chemicals and disposal of the resulting wastes, SPRU maintains a hazardous waste control program. Hazardous wastes are disposed through permitted off-site treatment and disposal facilities.

### 6.7.2 Chemical Control Program

The control program minimizes the quantity of waste material generated, ensures safe usage and storage of the materials at SPRU, and provides for proper disposal of the wastes through vendors that operate under permits issued by Federal and State agencies.

The control of hazardous substances for use at SPRU includes a review of waste minimization impact. Purchase orders for chemicals are reviewed to ensure that the materials are actually necessary for operations, the amount ordered is not excessive, and that methods for proper disposal are in place before the material is ordered. Hazardous substance storage controls include as a minimum: labeling, providing revetment as appropriate, segregation based on compatibility, limited storage volumes, and weather protection as appropriate. When required, large volumes of chemicals and petroleum products would be stored in accordance with the New York State Chemical Bulk Storage regulations and the Petroleum Bulk Storage regulations (Reference (14)). SPRU currently does not store any chemicals in quantities that are subject to the Chemical Bulk Storage regulations (Reference (13)) or the Petroleum Bulk Storage regulations (Reference (14)).

All personnel are provided with general information on the policies for the procurement, use, and disposal of hazardous substances. For individuals who use hazardous substances in operations, specific training is provided to ensure that they are knowledgeable of safe handling techniques and emergency response procedures. After chemicals are used and no longer needed, they are accumulated in designated staging and storage areas where they are segregated and packaged for shipment. Waste is temporarily stored only as necessary to accumulate sufficient volumes for shipment to a waste disposal vendor. SPRU has an inspection program to routinely verify that hazardous substances are properly stored and controlled in accordance with approved procedures.

### 6.7.3 Chemical Disposal

Hazardous waste is managed in compliance with the Resource Conservation and Recovery Act (RCRA). Generated waste is transported by vendors to treatment/storage/disposal facilities for final disposition. The transportation vendors and the treatment/storage/disposal facilities operate under permits issued by the cognizant Federal and State regulatory agencies. The disposal facilities provide itemized written verification that the waste was actually received. During 2013, SPRU shipped 775 lbs (approximately 0.39 tons) of RCRA and New York State hazardous waste off-site for disposal, including 281 lbs (0.14 tons) of universal waste. Approximately 0.56 cubic meters (0.7 cubic yards) of mixed low level waste (MLLW) was shipped off-site during 2013.

The SPRU hazardous waste program is governed by the Waste Management Plan (WMP-001) and implementing procedures. Prior to performing any waste generating activity at SPRU, the work package is evaluated for safety, minimization and compliance. Applicable process knowledge and existing conditions are evaluated and documented. This information, along with any additional sampling and analysis required, are used to make a hazardous waste determination for the waste stream, as well as to establish the initial categorization of the waste type. The waste determination process also includes consideration of the final disposition of the waste. This “cradle to grave” review plan ensures that the waste can be certified to TSDF acceptance criteria and that a generating activity will not generate a waste without a path forward.

Hazardous wastes that are not radioactive are packaged/treated/staged/transported and disposed consistent with the applicable (RCRA, NY State, TSCA, DOT) regulations. These wastes are disposed either by direct contract mechanism, by utilizing DOE’s broad spectrum contract mechanism, or through a qualified hazardous waste broker.

Approximately 9,885 lbs of non-hazardous chemical waste was sent off-site for disposal during 2013.

## 6.8 CONTROL OF RADIOACTIVE MATERIALS AND RADIOACTIVE WASTE

### 6.8.1 Sources

Operation of SPRU results in the generation of various types of radioactive materials and wastes. Low level radioactive solid waste materials that require disposal include debris, soil, filters, metal scrap, rags, resin, paper, and plastic materials.

### 6.8.2 Control Program

Detailed procedures are used for handling, packaging, transportation, and for disposal of radioactive waste at a government operated or licensed disposal site. Internal reviews are made prior to the shipment of any radioactive material from SPRU to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal requirements.

The volume of radioactive waste that results from radiological control activities is minimized through the use of work procedures that limit the amount of materials that become contaminated during work on radioactive systems and components. All radioactive wastes are prepared and shipped in accordance with written procedures to meet the applicable DOT regulations given in Reference (15). The waste packages also comply with all applicable requirements of the DOE and the disposal sites.

### 6.8.3 Disposal/Recycling

One hundred seventeen shipments of low level radioactive wastes were made by authorized common carriers to disposal sites located outside New York State. These shipments consisted of either water or solid form wastes as described in the next two paragraphs.

During 2013, 818 cubic meters (1,070 cubic yards) of water containing approximately 1.47E-01 curies was shipped from SPRU for disposal.

Approximately 89 cubic meters (116 cubic yards) of solidified radioactive sludge was shipped in 20 liners to the Waste Control Specialists disposal facility in Andrews, Texas in 2013. In addition, 49 shipments totaling approximately 680 cubic meters (889 cubic yards) of solid low level radioactive waste containing approximately 0.07 curies were shipped from SPRU for disposal. No net radioactivity above background was reported on package surveys.

## 6.9 CONTROL OF MIXED WASTE

### 6.9.1 Sources

A mixed waste is a waste that contains radioactive and hazardous components, as defined by the AEA and RCRA. Also, per NYSDEC, certain TSCA regulated PCB waste is also considered a hazardous waste. Operations at SPRU resulted in the generation of a small quantity of mixed wastes.

Radioactive wastes generated from SPRU activities that are determined to also be hazardous wastes, are packaged/treated/staged/transported and disposed consistent with the applicable (RCRA, NY State, TSCA, DOT) regulations. WMP-1 directs that these wastes be disposed of either by direct contract mechanism or by utilizing DOE’s broad spectrum contract mechanism.

### 6.9.2 Control Program

SPRU takes aggressive action to minimize the creation of mixed waste by reducing the commingling of radioactive and hazardous materials and avoiding the use of hazardous substances where practicable. The amount of generated mixed waste was also minimized through the use of detailed work procedures and worker training.

### 6.9.3 Storage and Disposal

All mixed wastes are accumulated in designated staging areas. Mixed wastes are packaged for storage and eventual shipment to off-site treatment facilities. In 2013, eight shipments of mixed wastes totaling 598 lbs were made to treatment and disposal facilities.

## 6.10 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 2013 operations at the Knolls Site had no measurable effect on normal background radioactivity levels. Therefore, any radiation doses from Knolls Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of the radiation dose to the maximally exposed individual in the vicinity of the Knolls Site and the collective dose to the population residing in the 80 kilometer (50 mile) radius assessment area are summarized in Section 7.0, Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the radiation protection standards of the DOE listed in Reference (4) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Knolls Site, was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole-body dose, demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions from the Knolls Site was less than one percent of the EPA standard in Reference (6).

The collective radiation dose to the public along the travel route from SPRU shipments of radioactive materials during 2013 was calculated using data and methods given by the NRC in Reference (17). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than ten person-rem. This is less than 0.01 percent of the dose received by the same population from natural background radiation.

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# 7.0 RADIATION DOSE ASSESSMENT AND METHODOLOGY

Measurements for radioactivity in environmental media representing an exposure pathway to man indicated no radioactivity attributable to operations at the Knolls Atomic Power Laboratory, Knolls Site and Kesselring Site. Therefore, potential doses to the general public from liquid and airborne effluents were too small to be measured and are estimated using conservative calculational techniques based on assumed pathways to man.

The exposure pathways via air and water considered for estimating radiation exposures were:

1. *Air Pathways*

   a. External exposure from airborne radioactivity and radioactivity deposited on the ground,

   b. Ingestion of food products, and

   c. Inhalation of airborne radioactivity.

2. *Water Pathways*

   a. Ingestion of water and fish,

   b. Ingestion of food products grown on irrigated land,

   c. External exposure from irrigated land, and

   d. Boating, swimming, and shoreline recreation.

For the Knolls Site and Kesselring Site, calculations were made to estimate: (1) the radiation dose to the maximally exposed individual in the vicinity of the Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site, and (3) the collective dose to the population residing in the assessment area. See Figure 7-1 for a map of the 80 kilometer (50 mile) assessment areas surrounding the two Sites.

The fundamental equation for calculation of the annual dose from a single radionuclide is:

$$D = XUK$$

where:

D = annual dose

X = the concentration of the radionuclide in the media of the exposure pathway of interest

U = the annual exposure time (hours) or intake (ml or kg) associated with the exposure pathway of interest

K = The annual dose factor for external exposure to a radionuclide or the dose commitment for a 50 year period from the current year's intake of a radionuclide

In estimating potential doses via the water pathway, the contribution from each radionuclide present in the liquid effluents to the effective dose equivalent was calculated using DOE dose conversion factors from References (22) and (23) and the Reference (24) liquid pathway model.

Estimates of potential doses via air pathways were calculated using CAP88-PC, Version 3.0, the EPA approved computer code package provided in Reference (25). The code package was prepared to implement the dose assessment required to demonstrate compliance with Reference (6). It includes the computer code AIRDOS2 and a file of the 50-year committed effective dose equivalent conversion factors calculated by the computer code DARTAB, which uses the dose factor database RADRISK using weighting factors from ICRP-72. CAP88-PC Version 3.0 is an updated version of CAP88-PC. It incorporates Federal Guidance Report 13 dose and risk factors.

In CAP88-PC Version 3.0, the area surrounding the site is divided into a circular grid defined by 16 pie-shaped segments, which are subdivided into sectors by annular rings out to 80 kilometers (50 miles). The computer code calculates the air concentration and surface deposition in each sector for each radionuclide released from the Site using site specific average atmospheric dispersion parameters. Dispersion parameters for each Site are based on on-site meteorological data summarized in accordance with Reference (26). Next, the radionuclide concentrations in meat, milk, and fresh vegetables produced in each sector are estimated using terrestrial food chain models. In CAP88-PC Version 3.0 the environmental radionuclide transfer factors were updated to the values from the National Council on Radiation Protection and Management Report 123 (NCRP-123). The code then calculates the effective dose equivalent to persons (adults) residing in each sector through the following exposure modes: (1) immersion in air containing radionuclides, (2) exposure to radionuclides deposited on ground surfaces, (3) inhalation of radionuclides in air, and (4) ingestion of food produced in the sector. The collective (population) effective dose equivalent is obtained by summing the product of the dose and population for each sector. The population residing within 80 kilometers (50 miles) of each site is based on the 2010 census data as reported in Reference (27).

The calculated doses are summarized in Tables 7-1 and 7-2. Ingestion of foodstuffs was the calculated principal exposure pathway for the hypothetical maximally exposed individual at the Knolls Site. At the Kesselring Site, the calculated principal exposure pathway for this hypothetical person was also ingestion of foodstuffs.

A comparison of the estimated (calculated) radiation dose to the maximally exposed individual from KAPL operations with the average radiation dose received from other sources is shown in Figure 7-2. Data in Figure 7-2 show that the maximum radiation dose that may have been received as a result of KAPL operations is much lower than the DOE radiation protection standard and the drinking water and air emission standards established by the EPA, and considerably lower than the average dose received from other sources (natural and man-made) of radiation.

## TABLE 7-1 ESTIMATED ANNUAL DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL AND ASSESSMENT AREA POPULATION FROM KNOLLS SITE OPERATIONS IN 2013

| Pathway | Dose to Maximally Exposed Individual (mrem) (Note 1) | (mSv) | % of DOE 100 mrem/yr Limit | Estimated Population Dose (person-rem) | (person-Sv) | Population within 80 Km | Estimated Background Radiation Population Dose (person-rem) |
|---|---|---|---|---|---|---|---|
| Air | 1.2E-03 | 1.2E-05 | 1.2E-03 (Note 2) | 3.6E-03 | 3.6E-05 | 1.36E06 (Note 3) | 9.4E04 (Note 4) |
| Water | 1.3E-04 | 1.3E-06 | 1.3E-04 | 7.7E-04 | 7.7E-06 | | |
| Other Pathways | None | | - | None | | | |
| All Pathways | 1.2E-03 | 1.2E-05 | 1.2E-03 | 4.4E-03 | 4.4E-05 | | |

Notes:

(1) The Maximally Exposed Individual for the Water Pathway case is in a different location than the Maximally Exposed Individual for the Air Pathway and All Pathways cases.
(2) The EPA Radionuclide NESHAPs standard is 10 mrem/year. Thus the dose is 0.012% of the EPA standard.
(3) Total population residing within 80 kilometers (50 miles) of the Knolls Laboratory based on 2010 census data as reported in Reference (27).
(4) Dose based on average off-site background radiation level determined for the Knolls Laboratory with TLDs as reported in Section 4.5. It does not include the estimated average annual effective dose equivalent of 29 mrem that a member of the population receives from naturally occurring radionuclides in the human body or the 228 mrem received from exposure to radon and its decay products as reported in Reference (28).

## TABLE 7-2 ESTIMATED ANNUAL DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL AND ASSESSMENT AREA POPULATION FROM KESSELRING SITE OPERATIONS IN 2013

| Pathway | Dose to Maximally Exposed Individual (mrem) (Note 1) | (mSv) | % of DOE 100 mrem/yr Limit | Estimated Population Dose (person-rem) | (person-Sv) | Population within 80 Km | Estimated Background Radiation Population Dose (person-rem) |
|---|---|---|---|---|---|---|---|
| Air | 2.0E-03 | 2.0E-05 | 2.0E-03 (Note 2) | 1.1E-02 | 1.1E-04 | 1.22E06 (Note 3) | 7.4E04 (Note 4) |
| Water | 6.3E-06 | 6.3E-08 | 6.3E-06 | 1.4E-06 | 1.4E-08 | | |
| Other Pathways | None | | - | None | | | |
| All Pathways | 2.0E-03 | 2.0E-05 | 2.0E-03 | 1.1E-02 | 1.1E-04 | | |

Notes:

(1) The Maximally Exposed Individual for the Water Pathway case is in a different location than the Maximally Exposed Individual for the Air Pathway and All Pathways cases
(2) The EPA Radionuclide NESHAPs standard is 10 mrem/year. Thus the dose is 0.02% of the EPA standard.
(3) Total population residing within 80 kilometers (50 miles) of the Kesselring Site based on 2010 census data as reported in Reference (27).
(4) Dose based on average off-site background radiation level determined for the Kesselring Site with TLDs as reported in Section 5.5. It does not include the estimated average annual effective dose equivalent of 29 mrem that a member of the population receives from naturally occurring radionuclides in the human body or the 228 mrem received from exposure to radon and its decay products as reported in Reference (28).

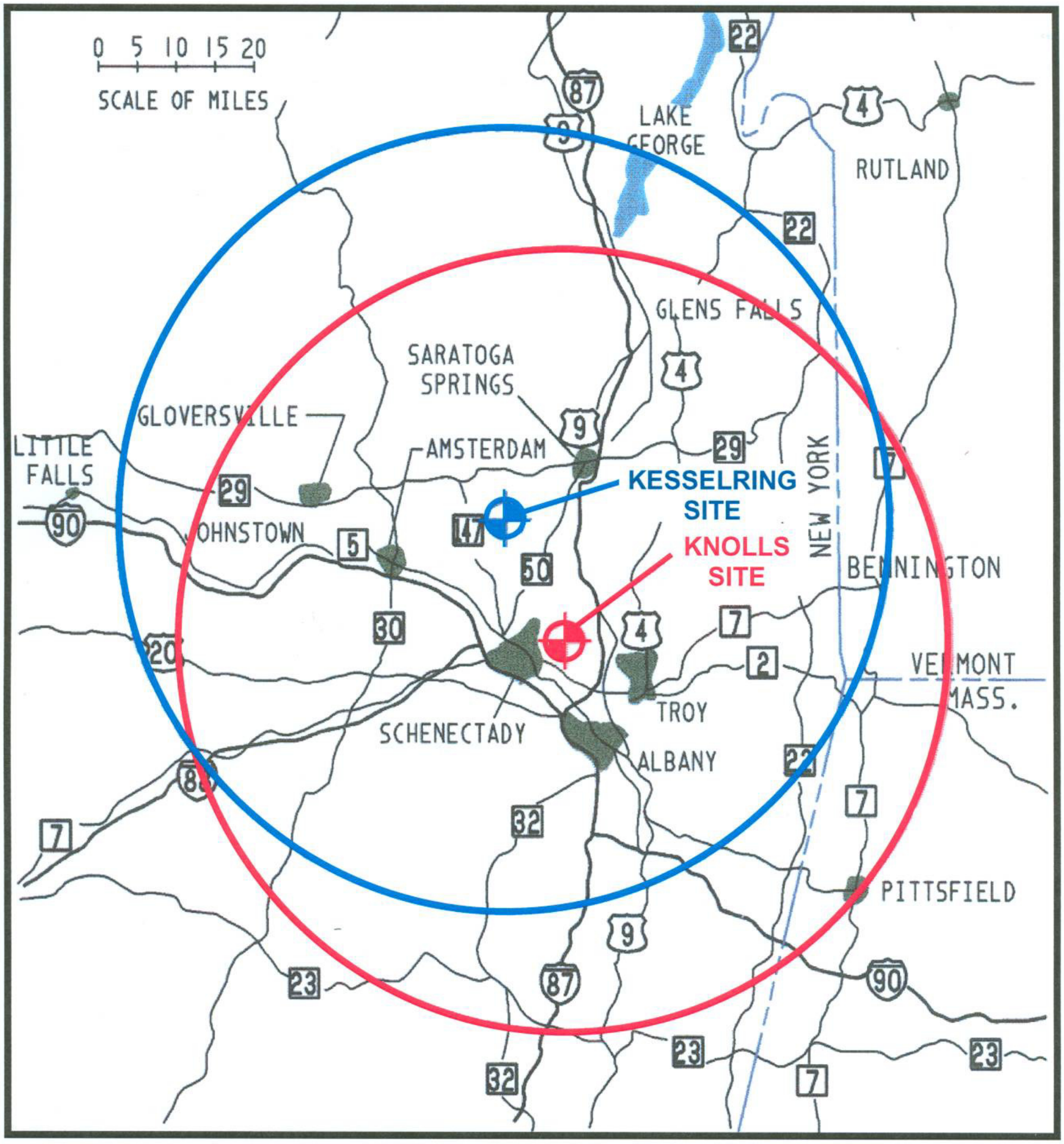


**Figure 7-1**
**Eighty Kilometer (50 mile) Assessment Area Map**
**for Knolls Site and Kesselring Site**

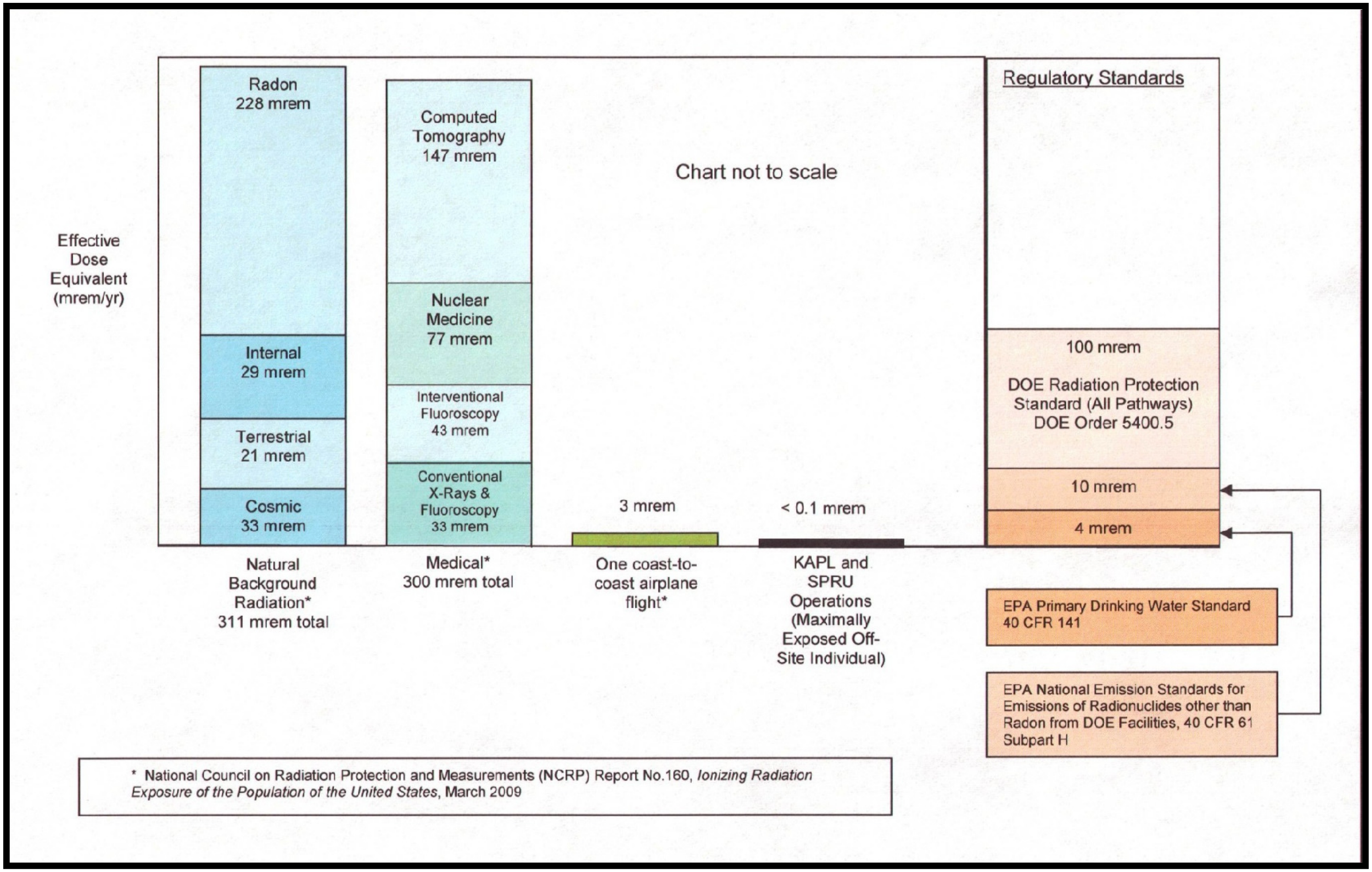


**Figure 7-2**
**Comparison of the Estimated Radiation Dose from KAPL Operations with Doses from Other Sources**

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# 8.0 QUALITY ASSURANCE PROGRAM

The KAPL Quality Assurance Program is conducted to ensure the accuracy and precision of effluent and environmental sampling, analysis, and reporting. The program is based on the guidance contained in several DOE, EPA, and NRC documents on the subject (References 29, 30, and 31, respectively).

The program for 2013 consisted of the following elements:

1. Internal quality assurance procedures
   a. Personnel training and qualification
   b. Written procedures for sampling, sample analysis, and computational methods
   c. Calibration of sampling and sample analysis equipment
   d. Internal quality assurance sample analyses
   e. Data review and computation check

2. Participation in a Quality Assessment Program (QAP) administered by a commercial laboratory, Environmental Resource Associates (ERA)

3. Subcontractor quality assurance procedures

4. Program audits

The internal quality assurance procedures start with the training of all personnel involved in the collection and analysis of samples, in accordance with established KAPL policies. Personnel are not permitted to perform sampling and sample analysis until they are trained and have demonstrated the ability to properly perform their duties. Written procedures, based on the methods recommended in References (29) and (31), cover collection and analysis of samples, the computation of results, and the calibration of sampling and analytical equipment, as required. Radioactivity counting equipment is, whenever possible, calibrated using standards that are traceable to the National Institute of Standards and Technology. Internal quality assurance procedures also provide for a system of duplicate (or replicate) analyses of the same sample and the analyses of spiked samples to demonstrate precision and accuracy. All measurement data are assessed to detect anomalies, unusual results, and trends.

KAPL participates in a QAP administered by a commercial laboratory, Environmental Resource Associates. The QAP provides an independent verification of the accuracy and precision of KAPL analyses of effluent and environmental monitoring samples. The results of KAPL participation in the ERA QAP are summarized in Table 8-1. The data demonstrate satisfactory KAPL performance.

Vendor subcontractor laboratories perform non-radioactive effluent and environmental sample analyses. KAPL maintains a quality assurance program to ensure the accuracy and precision of the subcontractor analytical results. This includes submitting blanks and replicate samples along with routine samples for analysis. If unsatisfactory results are obtained, follow-up investigations are performed to correct the problems. KAPL also requires vendor laboratories that perform analyses for the Knolls Laboratory and Kesselring Site be certified by the New York State Department of Health under the Environmental Laboratory Approval Program (ELAP).

Periodic audits are conducted that examine the effluent and environmental monitoring programs to ensure compliance with all KAPL procedures and applicable Federal and State regulations.

## TABLE 8-1 KAPL PERFORMANCE IN THE ENVIRONMENTAL RESOURCE ASSOCIATES (ERA) QUALITY ASSESSMENT PROGRAM, 2013

| Study Dates(1) | Sample Type | Analysis | KAPL Result(2) | ERA Assigned Value(2) | Acceptance Limits(3) |
|---|---|---|---|---|---|
| 03/18/13 to | Soil | Potassium-40 | 10.4 | 10.3 | 7.52 - 13.8 |
| 05/17/13 | | Cobalt-60 | 7.99 | 7.92 | 5.36 - 10.9 |
| | | Strontium-90 | 8.67 | 8.53 | 3.25 - 13.5 |
| | | Cesium-137 | 6.01 | 6.12 | 4.69 - 7.87 |
| | | Plutonium-239 | 0.355 | 0.366 | 0.239 - 0.506 |
| 03/18/13 to | Water | Tritium | 11.6 | 12.3 | 8.24 - 17.5 |
| 05/17/13 | | Cobalt-60 | 2.20 | 2.27 | 1.97 - 2.66 |
| | | Strontium-90 | 0.134 | 0.137 | 0.0892 - 0.181 |
| | | Cesium-137 | 1.81 | 1.88 | 1.60 - 2.25 |
| | | Plutonium-239 | 0.180 | 0.185 | 0.144 - 0.233 |
| | | Uranium-234 | 0.0501 | 0.0488 | 0.0367 - 0.0629 |
| | | Uranium-238 | 0.0492 | 0.0484 | 0.0369 - 0.0594 |
| | | Gross Alpha | 0.126 | 0.130 | 0.0462 - 0.201 |
| | | Gross Beta | 0.0758 | 0.0789 | 0.0452 - 0.117 |
| 03/18/13 to | Air Filter | Gross Alpha | 37.8 | 42.3 | 14.2 - 65.7 |
| 05/17/13 | | Gross Beta | 28.4 | 25.1 | 15.9 - 36.6 |
| | | Cobalt-60 | 217 | 214 | 166 - 267 |
| | | Cesium-137 | 950 | 940 | 706 - 1230 |
| 09/27/13 to | Soil | Potassium-40 | 10.5 | 12.4 | 9.08 - 16.7 |
| 11/26/13 | | Cobalt-60 | 5.62 | 5.68 | 3.84 - 7.82 |
| | | Cesium-137 | 4.09 | 4.13 | 3.16 - 5.31 |
| 09/27/13 to | Water | Tritium | 20.5 | 19.8 | 13.3 - 28.2 |
| 11/26/13 | | Cobalt-60 | 1.90 | 1.89 | 1.64 - 2.21 |
| | | Cesium-137 | 2.72 | 2.76 | 2.34 - 3.31 |
| | | Gross Alpha | 0.0789 | 0.0966 | 0.0343 - 0.150 |
| | | Gross Beta | 0.0861 | 0.0845 | 0.0484 - 0.125 |
| 09/27/13 to | Air Filter | Gross Alpha | 71.8 | 83.0 | 27.8 - 129 |
| 11/26/13 | | Gross Beta | 64.1 | 56.3 | 35.6 - 82.2 |
| | | Cobalt-60 | 499 | 494 | 382 - 617 |
| | | Cesium-137 | 611 | 602 | 452 - 791 |

Notes: (1) The study dates are assigned by ERA.
(2) The results are expressed in pCi/ml for water, pCi/g for soil, and pCi/filter for air filters.
(3) The acceptance limit range is provided by ERA.
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SPRU Quality Assurance Program

The DOE-EM Quality Assurance Program described in Revision 0 EM-QA-001 establishes EM expectations for quality assurance programs and the implementation of QA requirements EM complex-wide in the context of DOE Order 414.1C and Title 10 of the Code of Federal Regulations (CFR), Part 830, Subpart A. The EM QAP further adopts the use of the 2004 Edition of the American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facility Applications", Part I and the applicable subparts of Part II with Addenda through 2007 as a national consensus standard for QA requirements that apply to work accomplished by DOE EM and work accomplished by private organizations under contract with the DOE EM. Together, EM-QA-001, DOE Order 414.1C, 10 CFR 830 Subpart A and ANSI/ASME NQA-1-2004 Part I and the applicable subparts of Part II form the basis for the SPRU quality assurance programs.

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# 9.0 RADIATION AND RADIOACTIVITY – GENERAL INFORMATION

This section provides general information on radiation and radioactivity for those who may not be familiar with the terms and concepts.

Man has always lived in an environment where natural background radiation is present. This background radiation is as much a part of the earth's environment as is light and heat from the sun's rays. There are three principal sources of natural background radiation: cosmic radiation from the sun and outer space, radiation from the natural radioactivity in soil and rocks (called "terrestrial radiation"), and internal radiation from natural radioactive chemical elements that are part of our bodies. A basic knowledge of the concepts of radiation and radioactivity is important in understanding how effective control programs are in reducing radiation exposures and minimizing radioactivity releases to levels that are "as low as is reasonably achievable" (ALARA).

## 9.1 RADIATION

In simple terms, radiation is a form of energy. Microwaves, radio waves, x-rays, light, and heat are all common forms of radiation. The radiation from radioactive materials (radionuclides) is in the form of particles or rays. During the decay of radionuclides, alpha, beta, and gamma radiation can be emitted.

**Alpha radiation** consists of small, positively charged particles of low penetrating power that can be stopped by a sheet of paper. Radionuclides that emit alpha particles include radium, uranium, and thorium.

**Beta radiation** consists of negatively charged particles that are smaller than alpha particles but generally have more penetrating power and may require up to an inch of wood or other light material to be stopped. Examples of beta emitters include strontium-90, cesium-137, and cobalt-60.

**Gamma radiation** is an energy emission similar to an x-ray. Gamma rays have great penetrating power but can potentially be stopped by several feet of concrete or several inches of lead. The actual thickness required of a particular shielding material depends on the quantity and energy of the gamma rays to be stopped. Most radionuclides emit gamma rays along with beta or alpha particles.

Each radionuclide emits a unique combination of radiations that is like a "finger print" of that radionuclide. Alpha or beta particles and/or gamma rays are emitted in various combinations and energies. Radionuclides may be identified by measuring the type, relative amounts, and energy of the radiations emitted. Measurement of half-life and chemical properties may also be used to help identify radionuclides.

### 9.1.1 Radiation Dose Assessment

Body tissue can be damaged if enough energy from radiation is absorbed. The amount of energy absorbed by body tissue during radiation exposure is called an "absorbed dose." The potential biological effect resulting from a particular dose is based on a technically defined quantity called a "dose equivalent." The unit of dose equivalent is called the Roentgen equivalent man or "rem." Another quantity called "effective dose equivalent" is a dose summation that is used to estimate the risk of health-effects when the radiation dose is received from sources that are external to the body and from radioactive materials that are within the various body tissues. The traditional unit of effective dose equivalent, which is used in the United States is the rem, while the standard international (SI) unit is the Sievert (One Sievert is equal to 100 rem). The rem is a unit that is relatively large compared with the level of radiation doses received from natural background radiation or projected as a result of releases of radioactivity to the environment. The millirem (mrem,or one thousandth of a rem), is frequently used instead of the rem. The rem and mrem are better understood by relating to concepts that are more familiar.

Radiation comes from both natural and man-made sources. Natural background radiation includes cosmic radiation from the sun and outer space, terrestrial radiation from radioactivity in soil, radioactivity in the body, and inhaled radioactivity.

The National Council on Radiation Protection and Measurements estimates that the average member of the population of the United States receives an annual effective dose equivalent of approximately 311 mrem from natural background radiation. This is composed of approximately 33 mrem from cosmic radiation, 21 mrem from terrestrial radiation, 29 mrem from radioactivity within the body and 228 mrem from inhaled radon and its decay products. The cosmic radiation component in the United States varies from 22 mrem in Honolulu, Hawaii to 65 mrem in Colorado Springs, Colorado. The terrestrial component varies from about 10 mrem in the Atlantic and Gulf Coastal Plain to about 40 mrem in the mountainous regions of the west. The dose from inhaled radon and its decay products is the most variable because of fluctuations in radon concentrations within houses due to changes in weather patterns and other factors such as changes in living habits.

The average natural background radiation level measured in the vicinity of the KAPL Sites is approximately 70 mrem per year. Individual locations vary depending on soil composition, soil moisture content and snow cover.

In addition to natural background radiation, people are also exposed to man-made sources of radiation, such as medical and dental x-rays and conventional fluoroscopy, computed tomography, nuclear medicine, and interventional fluoroscopy. The average radiation dose from these sources is about 300 mrem per year. Other sources include consumer products such as building products (brick and concrete), lawn and garden fertilizer, loose leaf spinach and bananas. Additionally, an airplane trip typically results in a radiation exposure. A round-trip flight between the east and the west coast results in a dose of about 6 mrem.

## 9.2 RADIOACTIVITY

All materials are made up of atoms. In the case of a radioactive material, these atoms are unstable and give off energy in the form of rays or tiny particles as they attempt to reach a stable state. Each type of radioactive atom is called a radionuclide. Each radionuclide emits a characteristic form of radiation as it gives off energy. Radionuclides change as radiation occurs, and this transition is called radioactive decay. The rate at which a particular radionuclide decays is measured by its half-life. A half-life is the time required for one-half the radioactive atoms in a given amount of material to decay. For example, the half-life of the man-made radionuclide cobalt-60 is 5.3 years. This means that after a 5.3-year period, half of the original cobalt-60 atoms present will have decayed. The following 5.3 year period will result in half of the remaining cobalt-60 atoms to decay, and so on.

The half-lives of radionuclides vary greatly. For instance, the half-life of naturally occurring radon-220 is only 55 seconds, but the half-live of uranium-238, another naturally occurring radionuclide, is 4.5 billion years.

Through the decay process, each radionuclide changes into a different nuclide or atom - often becoming a different chemical element. For example, naturally occurring radioactive thorium-232, after emitting its radiation, transforms to a second radionuclide, which transforms to a third, and so on. Thus, a chain of eleven radionuclides is formed including radon-220, before non-radioactive lead-208 is formed. Each of the radionuclides in the series has its own characteristic half-life and type of radiation. The chain finally ends when the newest nuclide is stable. The uranium chain starts with uranium-238 and proceeds through 13 radionuclides, ending with stable lead-206. All of these naturally occurring radionuclides are present in trace amounts in the soil in your backyard as well as in many other environmental media.

### 9.2.1 Measuring Radioactivity

The curie (Ci) is the traditional unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. The analogous SI unit to the Ci is the Becquerel (Bq). Specifically, the Ci is the amount of radioactivity equal to $3.7 \times 10^{10}$ (37 billion) disintegrations per second and a Bq is equal to one disintegration per second. For environmental monitoring purposes, the Ci is usually too large a unit to work with conveniently and is broken down into smaller values such as the microcurie (µCi, one millionth of a curie or $10^{-6}$ Ci) and the pico-curie (pCi,one trillionth of a Ci or $10^{-12}$ Ci). Older wristwatches that were painted with radium to allow the numbers or segments to "glow in the dark" contained about one (1) µCi of radium. The average person has about one tenth (0.1) of a µCi of naturally occurring potassium-40 in his body. Typical soil and sediment samples contain about one (1) pCi of natural uranium per gram.

### 9.2.2 Sources of Radioactivity

Some of the radioactive atoms that exist in nature have always existed and natural processes are continually forming others. For example, uranium has always existed, it is radioactive, and it occurs in small but variable concentrations throughout the earth. Radioactive carbon and tritium, on the other hand, are formed by cosmic radiation striking atoms in the atmosphere. Radionuclides can also be created by man. For example, they are created in nuclear reactors and consist of fission products and activation products. Fission products are residues of the uranium fission process that produces the energy within the reactor. The fission process also produces neutrons that interact with structural and other materials in the reactor to form activation products. Because of the nature of the fission process, many fission products are radioactive. Most fission products have short half-lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of background fission-product radioactivity also exists in the environment, primarily due to past atmospheric nuclear weapons testing. Although the level is very low, these fission products are routinely detected in air, food, and water when analyzed with extremely sensitive instruments and techniques.

## 9.3 CONTROL OF RADIATION AND RADIOACTIVITY

To reduce the exposure of persons to ionizing radiation to "as low as reasonably achievable," controlling the use and disposal of radioactive materials and comprehensive monitoring programs to measure the effectiveness of these controls is required. Effluent streams that may contain radioactive materials must be treated by appropriate methods to remove the radioactive materials and the effluent monitored to ensure that these materials have been reduced to concentrations that are as low as is reasonably achievable and are well within all applicable guidelines and requirements prior to discharge.

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# 10.0 GLOSSARY

**Activation Products -** As cooling water circulates through the reactor, certain impurities present in the water and even components of the water itself can be converted to radioactive nuclides (they become "activated"). Important activation products present in reactor coolant water include radionuclides of corrosion and wear products (Co-60, Fe-59, Co-58, Cr-51), of impurities dissolved in the water (Ar-41, Na-24, C-14) and of atoms present in the water molecules (tritium). Of these, the predominant radionuclide and also the one with the most restrictive limits is Co-60.

**Algae -** Simple rootless plants that grow in bodies of water in relative proportion to the amount of nutrients available. Algae blooms, or sudden growth spurts can affect water quality adversely.

**Alkalinity -** The measurable ability of solutions or aqueous suspensions to neutralize an acid.

**Alpha Radioactivity -** A form of radioactivity exhibited by certain radionuclides characterized by emission of an alpha particle. Many naturally occurring radionuclides including radium, uranium, and thorium decay in this manner.

**Benthic Macroinvertebrates -** Small organisms inhabiting the bottom of lakes and streams or attached to stones or other submersed objects. The study of macroinvertebrate communities gives an indication of the overall quality of the body of water from which they are taken.

**Beta-Gamma Radioactivity -** A form of radioactivity characterized by emission of a beta particle and/or gamma rays. Many naturally occurring radionuclides such as Pb-212, Bi-212, and Bi-214 decay in this manner.

**Biochemical Oxygen Demand (BOD) -** The BOD test is used to measure the content of organic material in both wastewater and natural waters. BOD is an important parameter for stream and industrial waste studies and control of waste treatment plants because it measures the amount of oxygen consumed in the biological process of breaking down organic materials in the water.

**Birge-Ekman Dredge -** A device used for sampling the bottom sediment in rivers, streams, lakes, etc. The Birge-Ekman dredge is lowered to the bottom on a line and its spring-loaded "jaws" are remotely tripped from the surface. It samples an area of approximately 230 $cm^2$ to an average depth of 2.5 cm.

**British Thermal Unit (BTU) -** A unit commonly used to quantify the heat output of boilers, furnaces, etc. Specifically, the amount of heat necessary to raise 1 lb. of water one degree Fahrenheit.

**Chain Electro-Fishing Techniques -** A technique of collecting samples of fish from a body of water whereby the fish are stunned with an electric current, categorized, and returned to the water unharmed.

**Chemical Oxygen Demand (COD) -** A measure of the oxygen required to oxidize all compounds in water, organic and inorganic.

**Collective Dose Equivalent and Collective Effective Dose Equivalent -** The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-km radius and they are expressed in units of person-rem.

**Committed Dose Equivalent (CDE) -** The predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

**Committed Effective Dose Equivalent (CEDE) -** The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem.

**Composite Sample -** A sample that is comprised of a number of grab samples over the compositing period. In some cases the composite sample obtained may be proportional to effluent flow and is called a proportional sample or flow-composited sample.

**Conductivity -** A measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in water and the temperature at which the measurement is made.

**Confidence Interval -** Statistical terminology for the error interval (±) assigned to numerical data. A two sigma ($2\sigma$) confidence interval means there is 95% confidence that the true value (as opposed to the measured one) lies within the (±) interval. The 95% is the confidence level (See (±) value, Standard Deviation of the Average).

**Corrosion and Wear Products -** Piping and components used in construction of a nuclear reactor are fabricated from extremely durable, corrosion and wear resistant materials. Even under the best circumstances, however, small amounts of these materials enter the reactor coolant due to wear of moving parts and corrosion of the water contact surfaces of reactor plant components. While in no way affecting operational characteristics or reactor plant integrity, some of these corrosion and wear products may become activated as they pass through the reactor core. This necessitates that the reactor coolant be processed by filtration or other methods of purification before it is discharged or reused (See Activation Products).

**Curie (Ci) -** The common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to $3.7 \times 10^{10}$ (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to conveniently work with and is broken down to smaller values (See microcurie and pico-curie).

**Decision Level Concentration -** The quantity of radioactivity above which a decision is made that a net amount of radioactivity is present with a five percent probability of erroneously reporting net radioactivity when none is present (i.e., false positive).

**Derived Concentration Guide (DCG) -** The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem (0.1 rem).

**Dose Equivalent -** The quantity that expresses the biological effects of radiation doses from all types (alpha, beta-gamma) of radiation on a common scale. The unit of dose equivalent is the rem.

**Dosimeter – See Thermoluminescent Dosimeters**

**Duplicate Sample -** A sample that is created by splitting existing samples before analysis and treating each split sample as a separate sample. The samples are then analyzed as a quality assurance method to assess the precision in the analytical process.

**Ecosystem -** The integrated, interdependent system of plant and animal life existing in an environmental framework. Understanding of an entire ecosystem is important because changes or damage to one component of the system may have effects on others.

**Effective Dose Equivalent -** The sum of the dose equivalent to the whole body from external sources plus the dose equivalents to specific organs times a weighting factor appropriate for each organ. The weighting factor relates the effect of individual organ exposure relative to the effect of exposure to the whole body. The unit of effective dose equivalent is the rem.

**Eh -** A measure of the oxidation-reduction potential of water expressed in units of millivolts. The oxidation-reduction potential affects the behavior of many chemical constituents present in water in the environment.

**Field Blank -** A sample of laboratory distilled water that is put into a sample container at the field collection site and is processed from that point as a routine sample. Field blanks are used as a quality assurance method to detect contamination introduced by the sampling procedure.

**Fission Products -** During operation of a nuclear reactor, heat is produced by the fission (splitting) of "heavy" atoms, such as uranium, plutonium or thorium. The residue left after the splitting of these "heavy" atoms is a series of intermediate weight atoms generally termed "fission products." Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of background fission product radioactivity exists in the environment, primarily due to atmospheric nuclear weapons testing. The level is very low, but may be detectable when environmental samples are analyzed with extremely sensitive instruments and techniques such as those used by the Knolls Atomic Power Laboratory.

**Grab Sample -** A single sample that is collected and is representative of the stream or effluent.

**Half-life -** A value assigned to a radionuclide that specifies how long it takes for one half of a given quantity of radioactivity to decay away. Half-lives may range from fractions of a second to millions of years.

**High Purity Germanium Gamma Spectrometry -** A gamma ray measuring system designed for qualitative and quantitative determination of radionuclides present in a sample. Gamma spectrometry systems make use of the fact that during the decay of most radionuclides, one or more gamma rays are emitted at energy levels characteristic of the individual radionuclide. For example, during the decay of Co-60, two gamma rays of 1.17 and 1.33 million electron volts (MeV) are emitted while the decay of Ar-41 produces one gamma ray of 1.29 MeV. The high purity germanium detectors used in these systems are capable of detecting and very precisely resolving differences in gamma ray energy levels.

**Long-Lived Gamma Radioactivity -** Two very important characteristics of radionuclides are the length of time it takes for a given amount to decay away and the type of radiation emitted during decay. From an environmental standpoint, some of the most significant radionuclides are those whose half-lives are relatively long and that also emit penetrating gamma radiation during decay. Two radionuclides of concern in these respects are cobalt-60 (a corrosion and wear activation product) and Cs-137 (a fission product). (See Half-life, Beta-Gamma Radioactivity.)

**Macrophyton -** Macroscopic plants in an aquatic environment.

**Method Detection Limit -** The lowest value at which a non-radiological sample result shows a statistically positive difference from a sample in which no constituent is present.

**milligrams per liter (mg/l) -** A unit of concentration commonly used to express the levels of impurities present in a water sample. A milligram is one thousandth of a gram. One milligram per liter is equal to one part per million.

**micrograms per liter (µg/l) -** A unit of concentration commonly used to express the levels of impurities present in a water sample. A microgram is one millionth of a gram. One microgram per liter is equal to one part per billion.

**microcurie (µCi) -** One millionth of a curie ($10^{-6}$ curie). A typical smoke detector contains 1 µCi of Am-241 radioactive material (See Curie and picocurie).

**millirem (mrem) -** One thousandth of a rem ($10^{-3}$ rem).

**Outfall -** A point of discharge (e.g., drain or pipe) of liquid effluent into a stream, river, ditch, or other water body.

**Plankton -** Tiny plants and animals that live in water.

**Parshall Flume -** A specially constructed channel designed such that discharge water flow rate can be accurately measured. The Parshall Flume may also be instrumented to record the total volume of flow over long periods of time.

**Pasquill Stability Class -** A classification that defines the relative stability and dispersive capability of the atmosphere. Classification is highly dependent upon the change in temperature with height.

**Polychlorinated Biphenyls (PCBs) -** Halogenated aromatic hydrocarbons formed by the chlorination of biphenyl molecules. PCB's were commonly used in transformers as a dielectric fluid because of their stability.

**Periphyton -** Communities of microorganisms growing on stones, sticks, and other submerged surfaces. The quantities and types of periphyton present are very useful in assessing the effects of pollutants on lakes and streams.

**Person-Rem -** The sum of the individual dose equivalents or effective dose equivalents received by each member of a certain group or population. It is calculated by multiplying the average dose per person by the number of persons within a specific geographic area. For example, a thousand people each exposed to 0.001 rem would have a collective dose of one person-rem.

**pH -** A measure of the acidity or alkalinity of a solution on a scale of 0 to 14 (low is acidic, high is alkaline or caustic, 7 is neutral).

**picocurie (pCi) -** One trillionth of a curie ($10^{-12}$ curie). Typical soil and sediment samples contain about 1 pCi of natural uranium per gram. (See Curie and millicurie.)

**± Value (plus or minus value) -** An expression of the uncertainty in sample results. The magnitude of the (±) value depends on the number of samples, the size of the sample, intrinsic analytical uncertainties and the degree of confidence required. The (±) value assigned to data in this report is for the 95% confidence level (See Confidence Interval).

**Practical Quantitation Limit -** The lowest concentration that can be reliably achieved in non-radiological samples within specified limits of precision and accuracy during routine laboratory operating conditions.

**Radionuclides -** Atoms that exhibit radioactive properties. Standard practice for naming radionuclides is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt). There are several hundred known radionuclides, some of which are man-made and some of which are naturally occurring. Radionuclides can be differentiated by the types of radiation they emit, the energy of the radiation and the rate at which a known amount of the radionuclide decays away (See Half-life).

**Rem -** The unit of dose equivalent and effective dose equivalent.

**Reverse Osmosis -** Also known as hyper-filtration, it is a process that allows the separation of solutes (i.e., dissolved substances) from a solution by forcing the solvent through a semi-permeable membrane by applying a pressure greater than the osmotic pressure associated with the solutes. A semi-permeable membrane is a membrane that allows diffusion of solvent molecules through it, while retarding the diffusion of solute molecules.

**Resource Conservation and Recovery Act (RCRA) -** A Federal law that established a structure to track and regulate hazardous wastes from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

**Settleable Solids -** A measurement of the amount of solids that will settle out of a sample of water in a certain interval of time. This parameter commonly applies to water being processed in sewage treatment plants and is used to control the operation and evaluate the performance of these plants.

**Short-Lived Gamma Radioactivity -** Radioactive material of relatively short life that decays with the emission of gamma rays. It is generally not important with respect to environmental discharges because of the short life span. Some examples of short-lived gamma emitting radionuclides are Ar-41 (an activation product gas), Kr-88 (a fission product gas), and Xe-138 (a fission product gas).

**Spiked Sample -** A sample to which a known quantity of the material that is being analyzed for has been added for quality assurance testing.

**Standard Deviation of the Average -** A term used to characterize the uncertainty assigned to the mean of a set of analyzed data (See Confidence Interval, (±) Value).

**Suspended Solids -** Particulate matter, both organic and inorganic suspended in water. High levels of suspended solids not only affect the aesthetic quality of water by reducing clarity, but may also indirectly indicate other undesirable conditions present. The analysis for suspended solids is performed by passing a sample of water through a filter and weighing the residue.

**Surber Bottom Sampler -** A device for collecting samples of benthic macroinvertebrates from the bottom of relatively shallow, fast moving streams.

**Thermoluminescent Dosimeters (TLDs) -** Sensitive monitoring devices that absorb and store energy from radiation. The TLDs used by KAPL for environmental monitoring consist of small chips of lithium fluoride (LiF) encased in appropriate materials and strategically located at site perimeter and off-site locations. Thermoluminescent Dosimeters derive their name from a property that certain crystals exhibit when exposed to radiation and subsequently heated-that of emitting light proportional to the amount of radiation exposure received (thermoluminescence). The emitted light can then be read out on special instrumentation and correlated to the amount of radiation dose accumulated.

**Turbidity -** A cloudy condition in water due to suspended silt or organic matter. Turbidity is measured in nephelometric turbidity units (ntu).

**Upgradient -** Referring to the flow of groundwater, upgradient is analogous to upstream and is a point that is “before” an area of study that is used as a baseline for comparison with downgradient or downstream data.

**Volatile Organic Compound (VOC) -** An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

**Weight Percent -** A term commonly used to describe the amount of a substance in a material. For example, oil containing 0.5 lb. sulfur per 100 lb. oil would contain 0.5 percent by weight sulfur.

**Weighting Factor -** Tissue-specific representation of the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue.

**Whole Effluent Toxicity (WET) -** The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater. WET tests measure wastewater's effects on specific test organisms' (plants, vertebrates and invertebrates) ability to survive, grow, and reproduce.

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